Journal
of
Chemical Education

Published by
Division of Chemical Education of The American Chemical Society
Easton, Pa.

Entered as Second-class Matter, January 31, 1924, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized January 31, 1924

Vol. II **August, 1925** **No. 8**

CONTENTS

	Page
Editor's Outlook	628
Catalysis—A New Factor in Industry. Ellwood Hendrick	631
The Use of Charts and Graphs in Showing the Growth of Chemical Industries. Louis W. Mattern	649
Polar and Non-Polar Valences as Applied to Organic Chemistry. M. S. Kharasch	652
Finding and Salvaging the Superior Student. B. Clifford Hendricks	655
What Do Pupils Know of Chemistry When They Begin to Study It? Stephen G. Rich	659
Training for the Profession of Chemistry. M. L. Crossley	667
The Need for Research on Problems of High-School Chemistry Instruction. Earl R. Glenn	670
What Chemistry Does for the Druggist. Alfred S. Burdick	677
Analytical Chemistry at Pratt Institute—A Combination Course in Qualitative and Quantitative Analysis. Charles L. Mantell and Allen Rogers	681
Celestial Chemistry. C. E. Vail	685
Predicting Performance in Chemistry. Jacob Cornog and George D. Stoddard	701
Chemical Digest Abstracts	709
The Place of Science in the Secondary School	
A Standard Liberal Arts College	
College Qualifying Examinations	
Educational Value of Nature Study	
Chemical Quackery	
Inorganic Crystals	
The Tenth Revision of the United States Pharmacopoeia	
The Three-Year Course	
The Electrolytic Refining of Aluminum	
The Coking and Swelling Constituents of Coal	
Simple Methods for Removing Frozen-In Glass Stopcocks and Stoppers	
Synthetic versus By-Product Ammonia in Europe	
Bacteriological Chemistry and Industry	
Stop-Cock Lubrication and an Improved Lubricant	
The Man Who Soothed the Brow of Agony	
I Am a Chemist	
The Graduate Schools of America	
The Chemical Warfare Service and Pacifism	
The Rhodes Scholar's Ideal Professor	
An Outline of Obesity	
How Can We Humanize High-School Chemistry?	
The Inter-Relation of the Sciences	
Making Science Teaching More Effective in Relation to Life	
The Public School Teacher as a Research Worker	
Chemistry of Sewage Treatment	
Recent Developments in Photo-Chemistry	
Overlapping in High School and College	
British Assoc. of Chemists—The Overcrowding of the Profession	
Stainless Silver	
Stop Coal Dust Explosions	
Is This a Cure for Tuberculosis?	
Instinct as a Guide to Food	
Art of the Perfumer	
Electric Production of Chlorine Gas	
U-Tube Gas Generator	
Vanadium—A Curiosity among Minerals	
A Clearing House for High-School Information	
A Study of the Achievement of High-School Students in Chemistry	
The Philosophical Basis of Biochemistry	
To Extract Bromine from the Ocean	
Local Activities and Opportunities	717
Recent Books	719
A Few Moments with the Business Manager	723
"Our Shopping District"	724

BOSTON UNIVERSITY
COLLEGE OF LIBERAL ARTS
LIBRARY

EDITOR'S OUTLOOK

PREVENTIVE PEDAGOGY

The recent legal farce enacted at Dayton, Tennessee, has not directly affected teachers of chemistry as such. The science of chemistry does not readily lend itself to the vapid theorizing of religious and political demagogs. Fortunately they have not as yet succeeded in interpreting the Bible as the final, all-comprehensive and infallible text on chemistry. As students and teachers of science, as intelligent men and as exponents of intellectual integrity and courage we are, however, vitally interested in this latest and, we hope, final effort on the part of the forces of reaction and stupidity to discredit science in the popular mind by appeals to prejudice and superstition.

It is, perhaps, easy and pleasant for us as chemists to view with equanimity the entertainingly ridiculous antics of the fundamentalists; simultaneously sympathizing with our brother scientists—the biologists, geologists and astronomers—for the inconvenience occasioned them and congratulating ourselves upon the fact that as yet, at least, chemists may tell the truth about their own science without incurring the displeasure of the law and a certain portion of the Church. Undoubtedly it was just such an attitude of detached amusement on the part of intelligent Tennesseeans that has involved them in their present predicament.

The entire imaginary conflict between science and religion has its source in popular ignorance. Ignorance, not only of scientific subject-matter—that is not in itself so deplorable—but ignorance of the methods and aims of science and of what properly constitutes the respective fields of science and religion. Every scientist and particularly every teacher of science should consider it a moral duty to emphasize the following essential characteristics of the method of science:

(*a*) The sincere search for truth without reference to the effect of such truth upon previous opinion or belief.

(*b*) That any statement of the findings of science is in the nature of the case a statement of the balance of evidence and not a dogmatic assertion of finality. Even the "law" of gravity is subject to revision or restatement.

(*c*) That there is and can be no conflict between religion and science: to assert the contrary is to misunderstand the scope of both.*

With these considerations in mind, the people will begin to suspect what some of their would-be leaders fail to realize—to wit, that there must be something sadly amiss with an interpretation of religion which complains that the unbiased search for truth threatens to overthrow it. Scientists should not lightly dismiss the matter until the people as a whole

*Freedom of Teaching, *Science* **62,** 7–8 (1925).

are sufficiently enlightened to recognize the fact that there is no issue between science and true religion save that purposely fabricated by professional creators of issues.

THE ELECTRONIC CONCEPT

The ultimate goal of the natural philosopher has always been the discovery of the fundamental principle or principles whereby all the mysterious and apparently unrelated phenomena of nature might be correlated into a logical and harmonious whole. In the sphere of chemistry nothing has so greatly contributed toward this end as the electronic concept of the structure of matter. Imperfectly formulated as yet, insofar as its details are concerned, and improperly applied in many instances, it has, nevertheless, revolutionized and revivified chemical thinking.

Have we as teachers made the fullest possible use of this aid to the more intelligent study of chemistry and the better organization of the facts acquired in study? Has there not been too great a tendency to treat the electronic concept as an incidental annex to the main structure of chemical science, rather than as the foundation and steel skeleton-work upon and about which the entire edifice should properly be erected? If, as we claim, one of our objectives in teaching chemistry is to inculcate in our pupils logical and scientific habits of study and reasoning, are we not guilty of gross inconsistency when we teach empirically and fail to emphasize the very principles which entitle chemistry to be called a science?

In his article on "Polar and Non-Polar Valences as Applied to Organic Chemistry," published elsewhere in this issue, Dr. Kharasch points out that organic chemistry has been particularly open to criticism as lacking a fundamental and unifying concept. The present paper is introductory to a series in which he will discuss in some detail the experimentally supported application of the theory of partial polarity to the correlation of the diverse phenomena of organic chemistry with each other and with those of inorganic chemistry.

REPLACING DEMOCRACY WITH JUSTICE

To the educator it is tritely obvious that the much-advertised "equality of man" is a myth, at least insofar as mental capacity is concerned. As a corollary all educators agree that educational justice demands, not "equal distribution to all, but equal opportunity in proportion to capacity and previous attainment." No thinking man believes in unqualified democracy in principle. The best one can say of it is that it offers a popular and fairly practicable make-shift solution for many of the problems of political government.

We need not, therefore, dwell upon the point that the properly quali-

fied teacher can best fulfill his function as an educator and as an agent of justice by assuming the role of a benevolent autocrat and apportioning to his pupils instruction in accordance with their respective intellectual deserts. The question which is likely to give us pause involves, not the ideal to be pursued, but the ways and means of attaining that ideal.

Naturally, the first step toward the goal of intelligent discrimination must consist in the separation of the sheep from the goats. It is highly desirable that this separation be accomplished as early in the course as possible—preferably at the very beginning. In papers which appear in this issue, Dr. B. C. Hendricks, Dr. S. G. Rich and Profs. Cornog and Stoddard discuss the subject of classification tests and describe the results obtained with various kinds of tests.

DROP US A LINE

At the close of a recent chemical education symposium which both college and high-school instructors attended, several members of both groups took occasion to remark upon the mutual benefits derived from a coöperative consideration of the problems of each.

It is possible that some college men have paid too little attention to the pedagogical aspects of their work, deeming it sufficient if they are well-grounded and keep up-to-date in the subjects which they attempt to teach. The high-school teacher, particularly in the small school where the teaching load is heavy, is more apt to find himself open to the criticism that he is a far better teacher than he is a chemist. In most cases each has something to learn from the other.

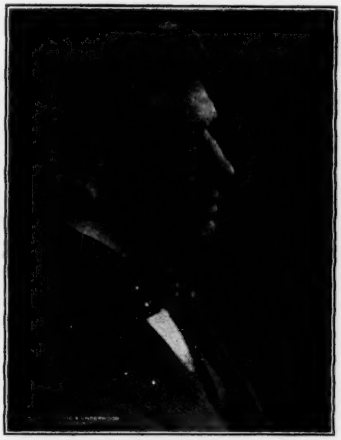
It is the aim of the JOURNAL to function as a monthly symposium on chemical education. It cannot furnish that personal contact among its readers that is so great an inspirational factor at every successful convention; heretofore it has not afforded an opportunity for the public discussion of papers presented. If the general sentiment appears favorable to such a project, however, it is the intention to inaugurate in an early issue a department devoted to correspondence, in which readers will have an opportunity to comment upon the ideas outlined in current articles. Here, also, they may express opinions or offer suggestions which could not be conveniently expanded into independent articles. Recommendations as to means of improving the JOURNAL and criticisms of its defects will always be entirely welcome.

Readers are invited to communicate with the editor-in-chief as to the desirability of such a department. Its establishment is contingent upon their expressed desire.

CATALYSIS—A NEW FACTOR IN INDUSTRY*

ELLWOOD HENDRICK, CURATOR, CHANDLER CHEMICAL MUSEUM, COLUMBIA UNIVERSITY, NEW YORK

The Catalyst—A Self-Starter
Chemistry—A Catalyst
Chemistry in Business
Catalysts at Work
The Manufacture of Sulfuric Acid
The Hydrogenation of Fats
The Fixation of Nitrogen
Synthetic Methanol
Acetic Acid
Future Possibilities of Catalysis



DR. ELLWOOD HENDRICK

Chemistry is much broader and bigger than we can see or hear or feel or taste or smell. It is an aspect of the Universe, and if we have not a sense of chemistry we are mentally blind; we cannot see with the eyes of the mind which imagination vouchsafes us, how and why things happen; how and why changes take place. Every plant, every animal, every living thing, is a chemical phenomenon and all gases and liquids and solids on the earth and in it and in the cosmic dust and far off in the starry heavens are first of all chemicals. The earth is full of romance and of riddles but when we let our imagination be guided by scholarship, clear beyond the realms that are familiar to us, way off into the invisible, inaudible, unfeelable world of things almost infinitely minute, we meet familiar things again.

We think of our earth as a great ball revolving around the sun and we see the reflected light of the sun on the other planets, so that in time we conceive an idea of our own solar system; of the comparatively small star, ninety-odd million miles away, that is the nucleus of our unit or system of the universe and of what it holds in gravitational leash. Then when we come to consider atoms, which are the smallest particles of any of the eighty-odd elements, we find in each atom what seems to be a similar solar system, with a nucleus of positive charges of electricity in the center, and, whirling round and round about it, a given number of negative charges or electrons that behave like so many planets. And yet they are so small as to tax the imagination; so small that if we were to set all the inhabitants of the earth to counting the atoms in a cubic centimeter of air—a mere

* Chapter I from Vol. II of *Chemistry in Industry*, to appear shortly. Published through the courtesy of the Editor, Dr. H. E. Howe.

thimbleful in which they are not at all crowded together—and were to have all the people count three a second continuously, working day and night, it would take them years to finish the job. But if we look hard enough, with the eyes of our minds, we seem to sense a certain uniformity of system in all the infinities, in the great and in the small, and even in the ways of people and of things.

We used to think that in the chemical elements we had reached the rock-bottom of the concept of matter, and that the elements were everlasting and eternal. We gave names to the elements, and one reason why chemistry often seems difficult to the beginner is because our emphasis on the names of things has made the gateway to science as pleasant and alluring as the multiplication table—but hardly more so. Now, following profounder study, it seems as though elements—surely it may be said of a considerable number of them—are but temporary stages in the cosmic history of matter. Matter seems to be in process of creation today, in the sun and in the stars, actually coming into being under conditions of temperature and pressure that we cannot reach either physically or chemically, just as was going on when this earth was hurled forth into space, a seething clod of cosmic stuff. And disintegration is going on continually on the earth, in planets, and in moons and satellites, here and in systems hundreds of thousands of light years away. Thus matter goes back into positive and negative charges of electricity, into protons and electrons, out of which all matter appears to be composed, and then is shot off into space—who knows but to participate in creation again? A stupendous and bewildering continuum!

We—little wisps of consciousness that we are, here today and gone tomorrow—have missed these things because of the shortness of our lives. We have been too willing and ready to call things everlasting because we could not see the beginning or the end; too much disposed to confuse even geologic ages with eternity. The philosophy of chemistry teaches us humility. And remember this: the more we study, the more we understand, and the loftier the heights we scale, the greater are the mysteries beyond.

The Catalyst—A Self-Starter

We need not, however, strive for the outermost reaches of the imagination to find familiar things in chemistry. There is, for instance, catalysis, which is one of the most human manifestations of matter. How often has it not happened to the reader of this chapter as well as to the writer, that we have been somewhere with friends and having a dull time of it. We have met, let us say, to draw up a set of resolutions, but we can't get much farther than "Whereas." Now "whereas" makes a good formal beginning, but we did not invent it; we merely remember it, and that is

easy. Not one of us is worth his salt at thinking up what to say. Each one wishes someone else would write the thing, because none of us feels like it. Then along comes another member of the committee who is not suffering from our disabilities; he thinks we should have our resolutions drawn up by the time he arrives; to him the whole thing is easy and he suggests merely a couple of "whereases" for a beginning. His presence, his voice, but more probably his energy changes us, and within five minutes we are all busy with suggestions, so that before twenty minutes or more have passed we have a set of resolutions that fairly sing, all written out.

Or, it may be that with no specific purpose other than mutual entertainment we are making a failure of it, all sitting in a ring, gloomy and sour. Then in comes the catalyst, cracks a few jokes, tells one on himself, is evidently glad to be there, and straightway we catch his spirit and engage in active talk, enjoying ourselves and counting the occasion a rare one. Merely because the catalyst came we have been changed from dull company into brilliant. How did it all happen? What did he do? Well, he catalyzed us, but we can write down every gesture he made and every word he said without explaining it.

Chemistry—A Catalyst

Now chemistry changes industry in just the same way, and when we get into chemistry we find catalysis, these sudden changes that take place in the presence of a sometimes exceedingly minute quantity of a seemingly foreign substance without which we cannot succeed in our undertaking.

As an example of how chemistry changes industry let us recall the story of several brothers whose father and grandfather had made soap—good laundry soap. They had a formula and good foremen and they made a decent living. The boys went to college, thanks to their father's provident habits and his ambition for them, and by the time they were back home again and getting to work the father died. Then they talked things over. Each was ambitious for himself and, while the business was big enough for one family, here were several in prospect and the head of each hoping to be a man of consequence and to live well. Should one take over the establishment and the others seek other occupations, or should they make the business big enough to take care of them all? They decided on the latter course and their first step was to find a competent chemist to introduce scientific control into the works. Soon they were using vegetable fats along with beef suet and mutton tallow; they ceased to produce by rule of thumb; they began to buy on specification and to manufacture under control. They added new products; the firm later became a leader in quality goods and now it is an immense concern with world-wide ramifications. It was chemistry, along with good business acumen, that made the change They never could have grown if they had stuck to the old methods.

Chemistry has only begun its work in industry, and it has far more to do than it has done so far. We are still back in the middle ages in the way we produce iron despite our big blast furnaces. Think, for instance, of the excessive heat required to warm up four volumes of nitrogen for every volume of oxygen that is needed hot. Or, if the iron master protests that the hot nitrogen helps him in his blast furnace, let's remember that theoretically and on a small scale it is possible to separate iron from its ore without either coke or limestone. It is the chemical engineer's business to turn the theoretical into the practical, and this is still awaiting development. Enough support of research with the right men might easily bring it about.

Again, the farmer buys fertilizer by the ton, paying excess freight on sixty to eighty per cent of useless material, and when he gets it he does not know what the functions of the various ingredients of the mixture are. Chemistry has got in far enough to tell the farmer that he is getting the equivalent of so many pounds of ammonia, so many pounds of phosphoric acid anhydride and so many pounds of potassium oxide per ton. He has learned the chemical names but he has not learned what's what.

This is no indictment of the iron or steel or fertilizer industries. It is told to show that when we look with the eye of science, we find it no virtue to be "up-to-date." To be up-to-date is to follow the donkey path, or, to express it more exactly, to be informed as to what living men have added to the work of the dead and to be equipped to profit by it. But chemistry looks way ahead and seeks to build up the great store of knowledge so that the present generation may do better than it is doing now as well as better than those who have gone before, and so that men and women of the future may do better than we do. Any man who is satisfied with being merely up-to-date is not fit to administer a chemical industry—and every industry is more or less a chemical industry. The only safe place is ahead of the game.

A number of years ago two gentlemen were traveling from Boston to New York and they had dinner together on the train. One was head of a great department store and the other was a well-known chemist. "I am one of those persons," said the merchant, "whose business your profession does not touch!" "I'd like to try," said the chemist, "in fact, if you will let me make a report on your store, and if you cannot save more than my fee every year, I'll provide the best dinner I can for you. And if you find that my examination of your place has been really worth while, then you can pay for the dinner." It was agreed, and the survey showed that, by buying on specification paper, twine, soap, cleansing powders and all such odds and ends, every one essentially a chemical product, the annual saving would be more than four times the chemist's fee. The merchant paid for the dinner.

We waste most of the lumber we cut, which chemistry could save. Of course such things can't be done by a mere twist o' the wrist. We are not blaming the lumbermen because they don't do what might be done. We, ourselves, might be found somewhat lacking along similar lines. It takes time and patience to work out such things, and then it takes courage to test them out.

Chemistry in Business

"To a certain extent, yes," as the king of bores says in reply to almost any question. There is the ghost of an indictment, or at least a warrant for a citation to show cause, that might be justly issued against American business in the matter of chemistry. Our corporation traditions provide that groups of investors be represented on boards of directors. The president is made a member, and the head of the sales department is likely to be added because the other members, consisting of bankers and merchants and a lawyer or so, can all understand what he says. The chief chemist is likely to be new in the business and it is seldom that his training has made him proficient in the discussion of loans and trade acceptances and stock issues and debentures or of finance and business procedure. He is likely to fit in somewhere between the general manager and the division superintendents. He speaks an unfamiliar language when he explains processes in which hydrolysis and colloidal aggregates and latent heats and reduction curves are involved. He can't get appropriations for research because he isn't understood; he can't make the directors see with his eyes.

Now in just such an establishment in Germany the managing director, a good part of the *Verwaltungsrat*, and nearly all the superintendents would be chemists and engineers with good chemical training. Men in administration—on the *Verwaltungsrat*—understand the problems much better than the American directors. They are as keenly interested in curves as they are in flow-sheets. They are familiar with that greatest of all sporting fields, the field of catalysis, and when the chief chemist, who invariably sits in council, tells his fellow-directors that Drs. Kleinschmidt and Heisterhagen of their research staff have discovered a new catalyst, for the production of one of their wares out of cheaper material, and that they use titanium dioxide, they know immediately that it is available, and the first questions they ask are about the yield, temperatures and pressures required, whether the titanium dioxide gets poisoned and how it is regenerated. Then, too, they know as well as the chemist how much it is likely to cost to test the process out on a semi-commercial scale, and they proceed to get busy. That is the way they keep ahead of the game: by a control organization that understands.

The imaginary situation would be equally well met by a few American corporations, but not by many of them. The others haven't got around to it yet.

Catalysts at Work

Now let us return more specifically to the subject of catalysis. It is an ancient art, but only recently studied earnestly in physical science. There are great tomes written on the subject, and a prevalent theory is that the catalyst is an accelerator; that the reaction is one already taking place, but very slowly, and that the catalyst merely speeds up the reaction. Some men of eminent scholarship oppose the theory; but we have no occasion to discuss the subject in this chapter.

The Manufacture of Sulfuric Acid

An ancient process relies upon the presence of nitrous oxides in sulfuric acid chambers to oxidize the vapor of burned sulfur or sulfur dioxide to the anhydride of sulfuric acid or sulfur trioxide. Sulfur trioxide combines with water to form sulfuric acid. The nitrous oxides are used over and over again to effect this change. But sulfuric acid is excessively hygroscopic, which means that it will draw water to it out of the air with an intensity that may be compared to "The Old Soak's" thirst under prohibition *in excelsis*. To get all the water out by heating the chamber acid is almost an impossibility.

When indigo came along, great quantities of fuming sulfuric acid were needed. This is 100 per cent H_2SO_4 with sulfur trioxide dissolved in it. It is also called *oleum* and it *has* acidic power! The problem was to find a catalyst to take the place of the nitrous oxides so that sulfur might be burned to sulfur dioxide which, on contact with a catalyst and in the presence of air, which contains 20 per cent oxygen, would be changed to sulfur trioxide. Platinum was found to do it completely, and some kinds of hot iron rust do it in part. So now, by the contact process, sulfur is burned and the fumes led first with air through hot iron rust and then through a platinum screen from which the sulfur trioxide falls like heavy snow. The platinum, which is very expensive and which will not act save on contact, is first dissolved as platinum chloride, and magnesium carbonate, which is a very porous body, is dipped into it. That covers the great area of surface with a thin film of platinum chloride solution. This is then calcined, whereby the chlorine and the carbonic acid are driven off, leaving magnesium oxide or magnesia, also very porous, with all its surfaces covered with platinum.

The Hydrogenation of Fats

Another turn in catalysis, which has been widely used for fifteen years or more, is the so-called hydrogenation of fats. All vegetable and animal

oils (but not mineral oils) and hard fats, such as lard or tallow, are closely related. Both oils and fats are compounds of organic acids with glycerol, and these oily and fatty acids are very much alike except for the fact that the fatty acids contain more hydrogen. Now we can bubble hydrogen gas through oils until the cows come home and very little, if anything, will happen. Everything remains as it was. But under proper conditions of temperature and pressure and in the presence of nickel, the hydrogen will somehow find its way into the oily acid molecules and change them to the fatty acid molecules, whereupon the oil becomes hard fat. Since this is a contact process, we need the greatest available surface of nickel and so we use it in very finely divided particles, because the smaller the particles, the greater the exposed surface of a given weight of the substance.

The Fixation of Nitrogen

Bradley and Lovejoy, two Americans, were the first to fix nitrogen from the air on a large scale and this they achieved by means of the electric arc at Niagara Falls. The yield was not satisfactory at the time because one little final experiment had not been tried, and the financial backers of the enterprise did not understand. So they called the whole thing off; they had wasted enough money already. A Norwegian saw what they were doing, bethought himself of the very simple last step, and the great nitrogen fixation industry established itself in Norway. But this was electrochemistry, and not catalysis.

At about the same time Professor Haber of Germany came along, saw what Bradley and Lovejoy were up to, and he resolved to fix nitrogen too. The electrochemical product was nitrate of lime. Haber knew they hadn't water power in Germany to follow out the established process, so he brought one volume of nitrogen gas and three of hydrogen together, and tried out a series of catalysts. He found the right one, and now the Haber process is the cheapest method we have for fixing nitrogen. The product is ammonia.

Following this came the war, and while there was plenty of ammonia available there was no source of nitric acid in Germany, and nitric acid is the first requisite in making explosives. But Ostwald had already discovered a method, now widely used, of oxidizing ammonia to nitric acid in the presence of a catalyst. And so the war went on.

Synthetic Methanol

Of late, American industry has been disturbed by the immense influx of methanol, otherwise called methyl alcohol or wood alcohol. It is a great solvent. The duty on it is considerable, but the German producers do not mind—they pay it and send more. The reason is, that they have found

a catalyst, said to be zinc oxide, which promotes the union of water gas and steam to produce an excellent yield of methanol, nearly 100 per cent pure. Water gas is generated by passing steam over very hot coke in a retort. Compare the cost of this process with that of chopping down hard wood, chipping the wood, distilling it, and then refining the product Competition between the two is impossible. But it takes long, patient, and expensive investigation to get results from such simple directions. The right apparatus must be discovered, the temperature and pressure for maximum yield determined, and the chances are ten to one that the catalyst has ways of its own that are devious. The reaction may proceed better in the presence of something other than zinc oxide.

Acetic Acid

Up in Canada at Shawinigan Falls they make calcium carbide by electrochemical means: carbon and lime are combined by means of tremendous electric energy. Calcium carbide and water produce acetylene. Acetylene brought into contact with a catalyst under right conditions (originally, I believe, they used mercuric oxide but now they have a cheaper and better medium), becomes acetaldehyde, and acetaldehyde with manganese sulfate as catalyst becomes glacial acetic acid which comes out of the reacting chamber like soft ice as thick as a man's arm. This again is cheaper than distilling hard wood and treating the acetate of lime with sulfuric acid and boiling down the remaining acid to proper concentration.

Ethyl alcohol, as John Barleycorn, itself said to be a catalyst to talk and song and all kinds of devilment, is probably on the way to catalytic birth. So are other things. But such matters are not to be talked of until they are brought about.

Future Possibilities of Catalysis

There's another possibility in the offing, not yet here, but which may come along some day. It is complex, bewildering, and bound to be full of disappointments, but none the less it is sure to develop in time. One of the unsolved riddles of chemistry is the precise constitution of a lump of coal. There are combinations of carbon and hydrogen and oxygen and nitrogen there that go to pieces as soon as we undertake to find out just what they are. Now a German chemist named Bergius has succeeded, principally by means of high pressures, in introducing hydrogen into heavy oils and also into bituminous coal so that the latter takes on the liquid character of a crude petroleum. Suppose, then, some chemist were to discover a catalytic method of hydrogenating bituminous coal so that it became liquid, and that this method should become economically possible. Please close the book for a few moments at this point and think what such a discovery would mean. Liquid fuel for everything. No more stoking, no

more smoke or cinders, no more worry about the waning supply of petroleum. And no more coal bins.

Chemistry hasn't more than begun to do its proper work for the people yet.

Catalysis, we repeat, is the sporty end of chemistry. The "reasons why" are not clear, the theories are not developed, and, because we know so little of the subject as yet, procedure goes principally by way of trial and error. Sometimes discoveries are made by accident. In the Badische Works in Germany, when they were working on the synthesis of indigo, they needed phthalic acid as an intermediate material. It was expensive, but they reasoned out that they should be able to obtain it by treating naphthalene (which is the white tar product used for making moth balls) with fuming sulfuric acid or oleum. The theory was all right, there was every known reason why it should work, but all the same it didn't. Neither heat nor pressure nor any other strategem could be made to bring about the desired result. Of course there was no reason to give up the effort, but it was disheartening to meet failure after failure with every attempt to accomplish that transition from naphthalene to phthalic acid. One day, while one of these experiments was in progress, a laboratory boy was told to take a reading from a thermometer. He was a clumsy lad, and he broke the instrument so that a few drops of the mercury fell into the mass. Straightway something happened. The stuff began to seethe and labor, and within a little while there wasn't any naphthalene left; the container was full of the desired phthalic acid. Mercury proved to be the catalyst.

So we might go on filling page after page with catalytic stories and stories of enzymes, which are organic catalysts, and effect remarkable changes in the processes of life. The field is immense, amazing, bewildering, romantic, exciting—and we have uncovered only a tiny little edge of the great pall of the unknown, which covers it all.

General Organic Chemistry Symposium. Arrangements are being made for a general symposium on organic chemistry to be held at Rochester, N. Y. on Dec. 29, 30, and 31, 1925. The symposium will be held under the auspices of the Organic Division of the A. C. S. with the Rochester Section acting as host. It is not the intention to limit the papers presented to absolutely new subject matter. Many contributions will undoubtedly take the form of resumés of the particular fields treated.

This meeting is in accordance with the idea that it would be an excellent thing for the organic chemists of the country to assemble once a year and discuss topics of general interest. The present meeting place has been selected with a view to accessibility to organic industrial enterprises.

It has been suggested that the papers presented might profitably be assembled in a monograph similar to that which has followed each of the Colloid Symposiums. No definite arrangements for this publication have been made as yet, however.

THE USE OF CHARTS AND GRAPHS IN SHOWING THE GROWTH OF CHEMICAL INDUSTRIES*

LOUIS W. MATTERN, MCKINLEY TECHNICAL HIGH SCHOOL, WASHINGTON, D. C.

Professor Charles E. Munroe, Expert Agent in charge of Chemicals and Allied Products at the U. S. Censuses 1900–1905–1910 had several charts prepared which he used in such an instructive manner during the course of an address[1] as to inspire the suggestion that the large body of the statistics of all censuses under the same heading could be used in producing a system of charts and graphs useful to teachers, students and manufacturers. Data on some of the leading chemical industries have been selected for use in this article.

A tribute of general appreciation is due this Nestor of chemistry for the important part he played during the above censuses in helping to bring about a more comprehensive classification of statistics bearing on Chemical and Allied Industries.[2,3,4]

The author is especially indebted to Mr. William W. Stewart, Director of the United States Bureau of Census for the courtesy of conferring, in an unusually satisfactory manner, in the correlation of statistics and in the preparation of charts and graphs used in this article.

A study of the number and location of Chemical Industries on a map of the United States in connection with our nation-wide need of their productions and of our resources for supplying the raw materials for these industries will bring to the student's mind the important broadening effect of the significance of chemistry in our national life. The visualization of the growth of chemical industries by the use of graphs brings quickly and forcibly to the student's mind the vastness of their productions and affords a basis for interesting discussions about the important factors of these momentous industries. Views of such maps and graphs introduced at the proper places in a chemical course would help to create a greater interest in the subject at hand and in the often seemingly dry topics—atoms, molecules, ions and laws governing their transformations—by causing the student to realize that these topics are exceedingly important, not as terminals at examination times, but as thoroughfares to great industries. What student would not be thrilled with a determination to acquire, promote, and utilize chemical knowledge when he sees the vast fruitage of such information in the fields of our economic life, which in turn enriches all other departments of human existence?

* Presented before the Division of Chemical Education, American Chemical Society, at Baltimore, April 8, 1925.

[1] "Importance of Teaching Chemistry," THIS JOURNAL, January, 1925.

[2] Census Bulletin No. **210,** 1902. 12th Census of the U. S.

[3] Census Manufacturers; 1905 Chemical and Allied Products, Bulletin **92,** p. 9.

[4] "The Chemical Industries of America," *Transactions of the American Institute of Chemical Engineers,* Vol. **II,** 1909.

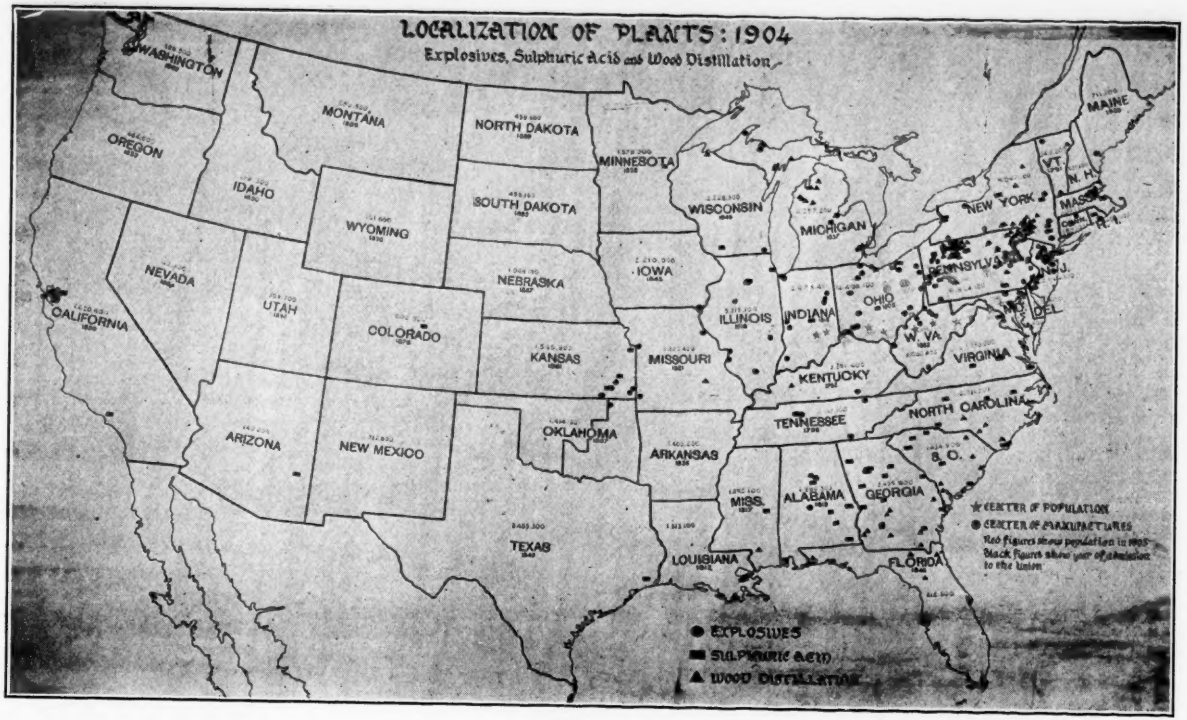

LOCALIZATION OF PLANTS: 1904
Explosives, Sulphuric Acid and Wood Distillation
WASHINGTON
OREGON
CALIFORNIA
IDAHO
NEVADA
MONTANA
WYOMING
UTAH
COLORADO
ARIZONA
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISS.
ALABAMA
GEORGIA
FLORIDA
S. C.
N. C.
VIRGINIA
W. VA.
PENNSYLVANIA
NEW YORK
MAINE
VT.
N. H.
MASS.
R. I.
N. J.
DEL.
MD.
★ CENTER OF POPULATION
● CENTER OF MANUFACTURES
Red figures show population in 1900
Black figures show year of admission to the Union
● EXPLOSIVES
▬ SULPHURIC ACID
▲ WOOD DISTILLATION

FIG. 1.

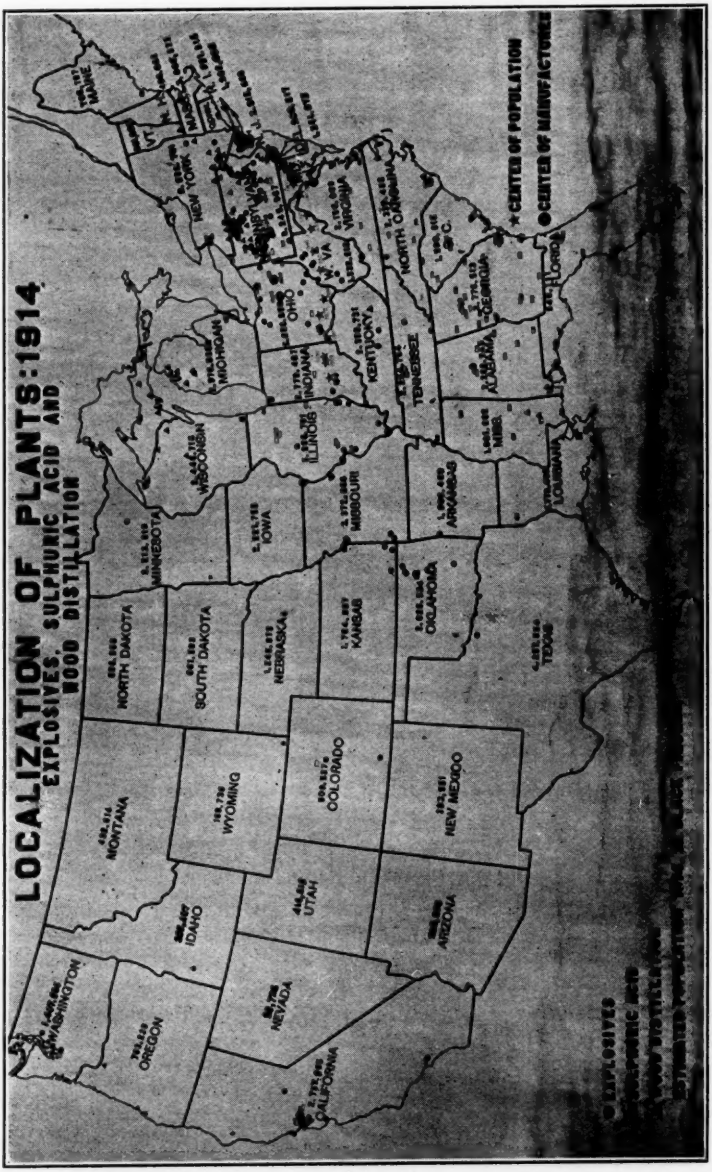

LOCALIZATION OF PLANTS: 1914
EXPLOSIVES, SULPHURIC ACID AND WOOD DISTILLATION
CENTER OF POPULATION
CENTER OF MANUFACTURE
EXPLOSIVES
WASHINGTON
OREGON
CALIFORNIA
IDAHO
NEVADA
MONTANA
WYOMING
UTAH
ARIZONA
COLORADO
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISS.
ALABAMA
GEORGIA
FLORIDA
S. C.
N. C.
VIRGINIA
W. VA.
PA.
NEW YORK
MAINE

FIG. 2.

The statements accompanying these views[5] are only suggestive and wider interpretations of their significance may be made before classes, depending on the time at hand, knowledge of chemical processes, conditions, uses for products, and resources of materials.

The author is indebted to Professor Munroe for the use of Figures 1 and 2 which he had prepared through the courtesy of the Bureau of Census. Notwithstanding the importance of the three typical industries whose locations are shown thereon, it appears that in Fig. 1 for 1904, Arkansas, Idaho, Iowa, Montana, Nebraska, Nevada, New Hampshire, New Mexico, North Dakota, South Dakota, Utah, and Wyoming did not have any of these industries. There were 28 of these industries west of the Mississippi

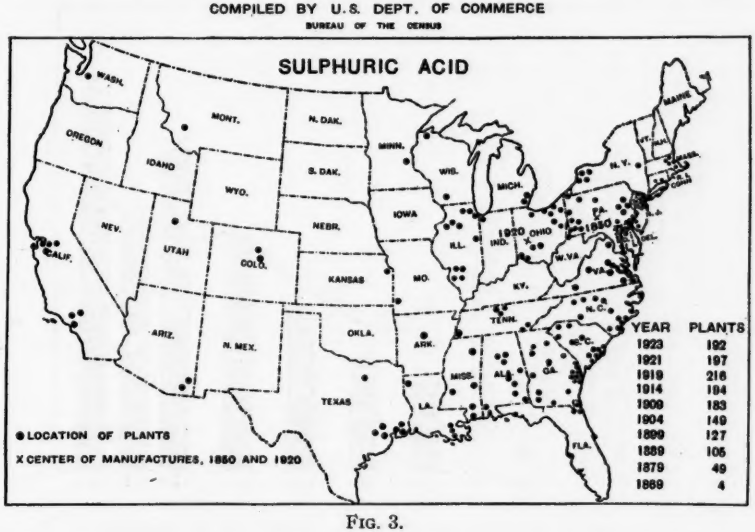


FIG. 3.

River and 312 east of it. These states, plus Delaware, Kentucky, Maine, Minnesota, Missouri, Oklahoma, Washington and West Virginia did not have a single sulfuric acid manufacturing establishment. Of the 149 sulfuric acid plants in the United States, Georgia with its 13 had as many as the entire area west of the Mississippi River.

From Fig. 2 it is noted that after a decade the great West with latent resources, did not increase its number of sulfuric acid establishments. East of the Mississippi River there was a gain of 45, principally in the South and in New Jersey.

[5] Lantern slides of any view in this article suitable for use in class-rooms may be obtained through the author. To Mr. J. Harper Snapp of the Geophysical Laboratory, the author is indebted for photographs of all the cuts.

Figure 3. In 1923 it appears that there were 30 sulfuric acid manufacturing establishments west of and 162 east of the Mississippi River which is a decrease of 2 in the East and an increase of 17 in the West over 1914. The new phosphatic deposits in Montana, the probable need of more phosphates, the manufacture of explosives, and oil refining, sulfide ores—all will likely give rise to more sulfuric acid establishments in the West. An insert shows the number of establishments manufacturing sulfuric acid for each census back to that of 1869.

Figure 4. The chemical commodity which in one way or other is a factor in most, if not all, of the chemical industries, is sulfuric acid; hence

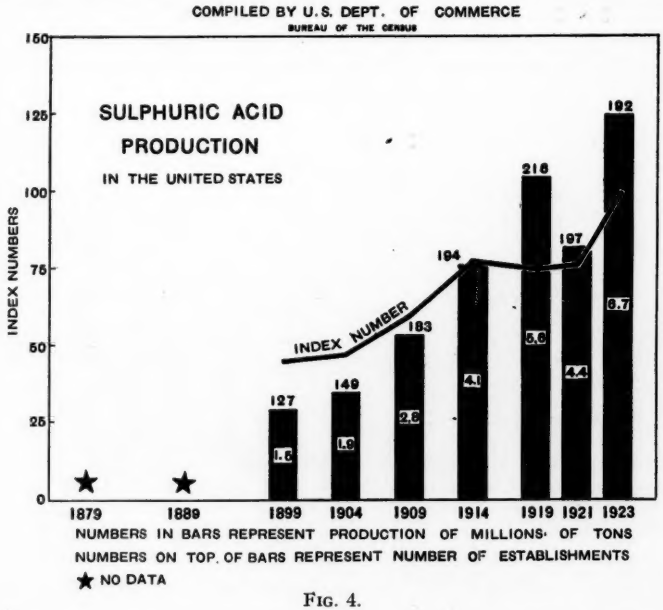


FIG. 4.

its production can be taken as an index of the growth of such industries as a whole. The production here represented includes not only that made for sale but also that made and consumed in the same establishment in the manufacture of the products of the various industries designated as fertilizers, explosives, petroleum refining, etc., and hence can be taken as an index of the growth of chemical industries but not necessarily for the industries separately.

Index Numbers. The total tonnage of sulfuric acid taken in connection with the number of wage earners employed in all industries within the group constitutes the basic data. Thus in 1899 all industries within this major

group employed 196,338 wage earners, and the total production of sulfuric acid was 1,548,123 tons. In 1923 the aggregate number of wage earners for all industries within the group was 384,493 and the total production of sulfuric acid had increased to 6,672,628 tons. Dividing the sulfuric acid tonnage by the number of wage earners for the successive census years, the following averages per wage earner resulted—1899, 7.9 tons; 1904, 8.2 tons; 1909, 10.3 tons; 1914, 13.6 tons; 1919, 13 tons; 1921, 13.3 tons; and 1923, 17.4 tons.

The index numbers are deduced from these averages, taking 1923 as 100, ranging as follows—1923, 100; 1921, 76; 1919, 75; 1914, 78; 1909,

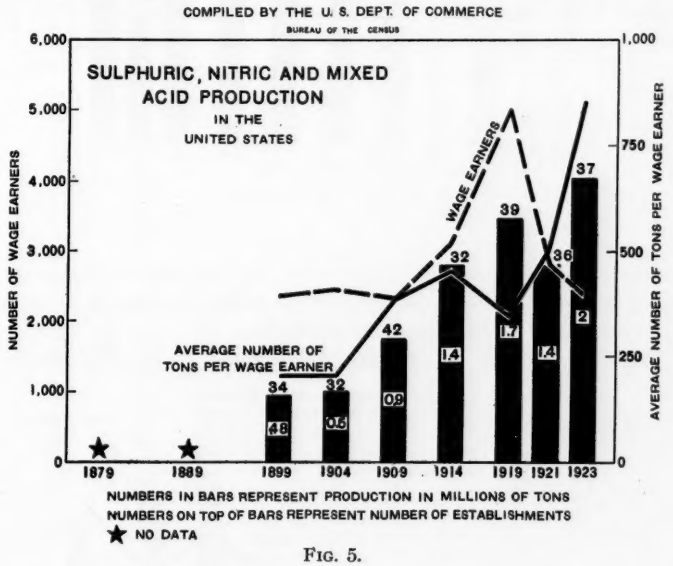


FIG. 5.

59; 1904, 47; 1899, 45—that is the productivity per wage earner in 1923 (based upon sulfuric acid production as the yard stick) is taken as 100 per cent and the relative percentages for the preceding census years are 76, 75, 78, 59, 47 and 45.

In this and succeeding views, the number of establishments at the top of a bar divided into the production shown by the number in the bar will give the production per average establishment at each census. Aside from the depression following the war, it thus appears that the 1923 census showed 2.94 times greater average production per establishment than the 1899 census. The index number line shows a large advance in the average amount produced by each wage earner. Both these factors would seem to indicate larger establishments or improvements in processes.

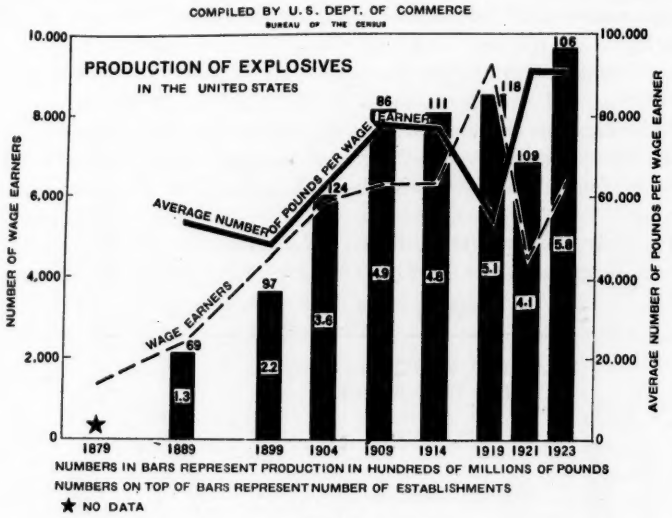


FIG. 6.

Figure 5. In this and succeeding views, the number of wage earners is plotted against the left-hand ordinate and the average production per wage earner against the right-hand ordinate.

The production for the average establishment at the 1923 census was

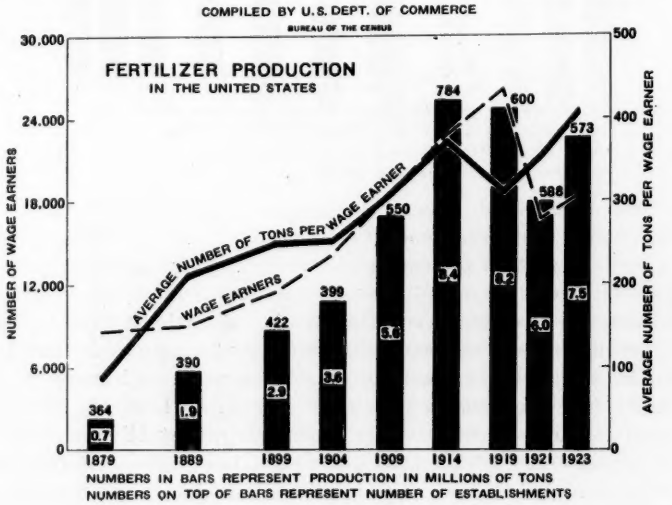


FIG. 7.

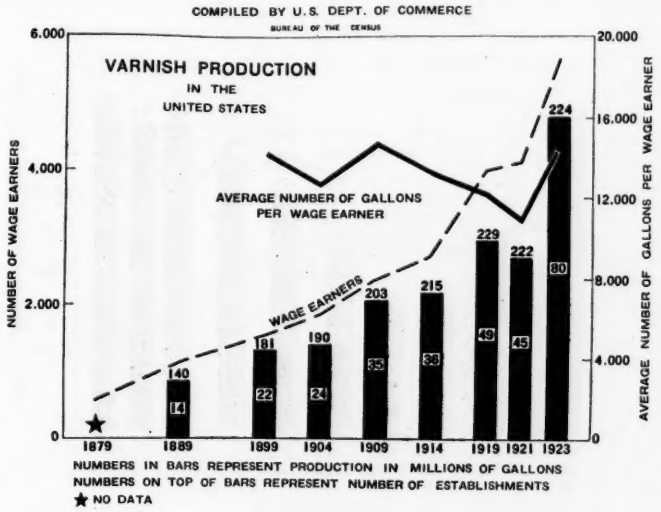


FIG. 8.

3.82 times as great as that of 1899. The average increase in production for the wage earner at the same censuses was 4.3 times.

Figure 6. Production per average establishment at the 1923 was 2.9

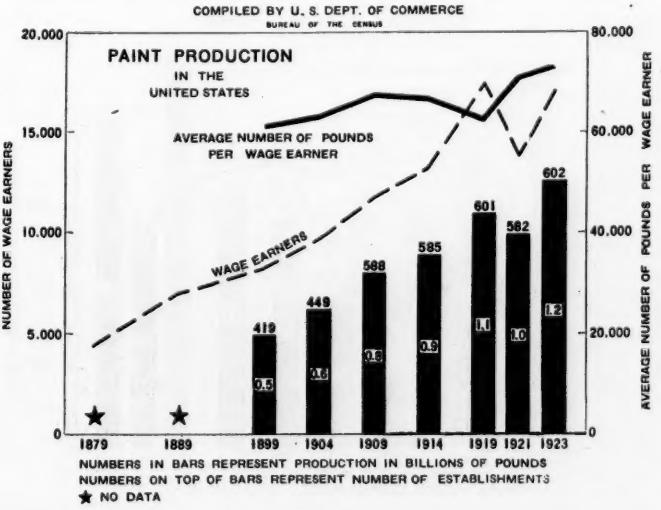


FIG. 9.

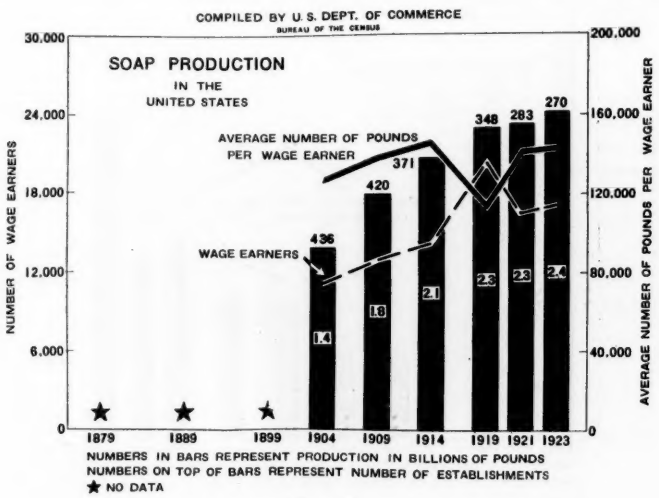


FIG. 10.

times that of 1889. The average increase per production for the wage earner at the same censuses was 4.1 times.

Figure 7. Census 1923 increase in output for average establishment was 6.71 times that of 1879. Census 1923 increase in output for average wage earner was 10 times that of 1879.

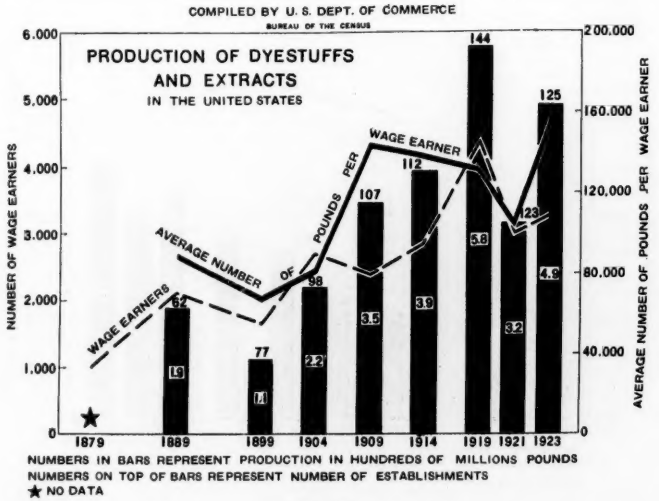


FIG. 11.

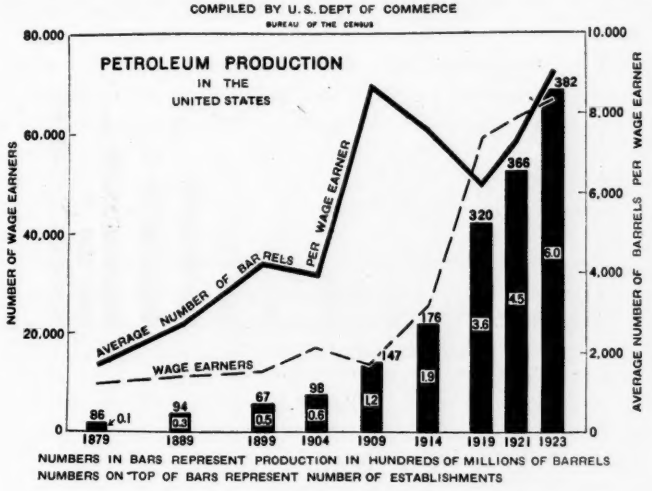


FIG. 12.

Figure 8. Census 1923 increase in output for average establishment was 3.57 times that of 1889. Census 1923 increase in output for average wage earner was 5.8 times that of 1889.

Figure 9. Census 1923 increase in output for average establishment

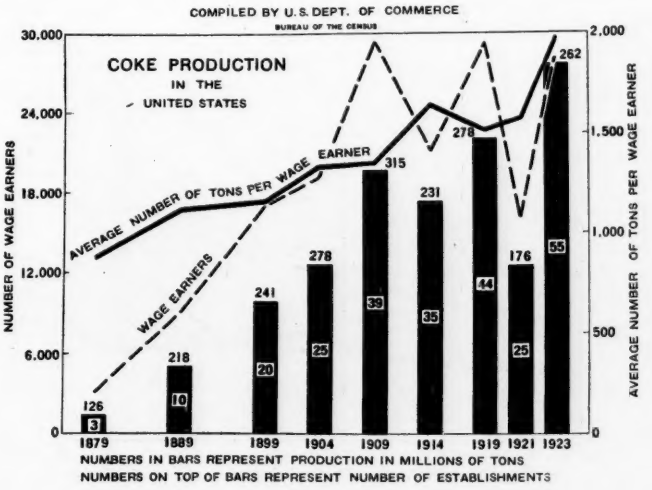


FIG. 13.

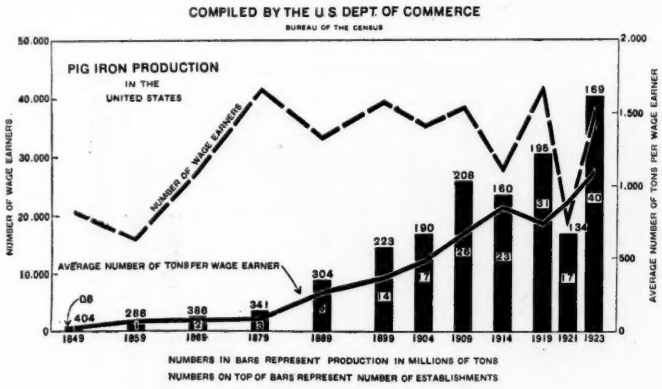


FIG. 14.

was 1.08 times that of 1899. Census 1923 increase in output for average wage earner was 2.6 times that of 1899.

Figure 10. Census 1923 increase in output for average establishment was 2.77 times that of 1904. Census 1923 increase in output for average wage earner was 1.7 times that of 1904.

Figure 11. Census 1923 increase in output for average establishment

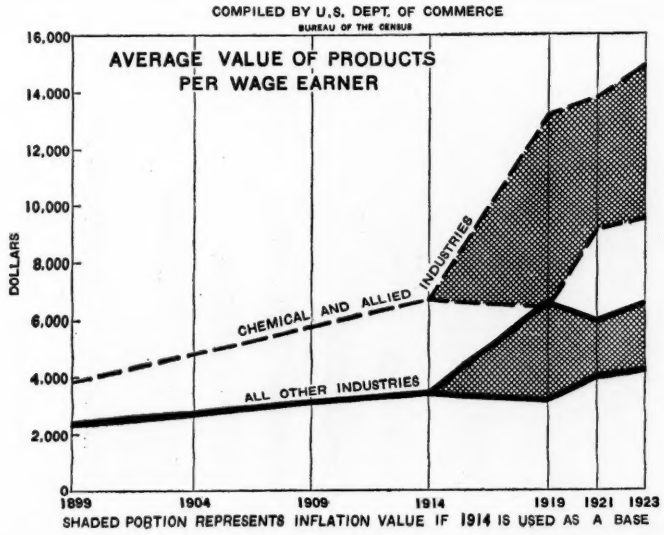


FIG. 15.

was 1.26 times that of 1889. Census 1923 increase in output for average wage earner was 2.6 times that of 1889.

Figure 12. The importance of this basic material led to the preparation of this chart. Census 1923 increase in output for average establishment was 13.44 times that of 1879. Census 1923 increase in output for average wage earner was 34.2 times that of 1879.

Figure 13. Census 1923 increase in output for average establishment was 8.90 times that of 1879. Census 1923 increase in output for average wage earner was 21.1 times that of 1879.

Figure 14. Census 1923 increase in output for average establishment was 166.1 times that of 1849. Census 1923 increase in output for average wage earner was 48.9 times that of 1849.

Figure 15. From left to right there may be noted for each census from 1899 to 1923 a comparison between the average value of products per wage earner in all chemical and allied industries and all other industries. The inflation value is so represented as to make this comparison continuous. Thus, there is revealed to the student by this comparison the enormous importance of chemistry in industry from a financial viewpoint and the gradual increase of that importance at each succeeding census.

Don't Drink Methanol! It's Poisonous.—Methanol, the synthetic alcohol which is now being made cheaply in Germany, is just as poisonous as the similar wood or methyl alcohol, despite claims that the foreign product, because of its high purity, is harmless. This statement is made by Dr. Reid Hunt, of the Harvard Medical School, in "Industrial and Engineering Chemistry," following a series of experiments.

"The results with the German (synthetic) methanol were the same as those obtained with pure methyl alcohol obtained from wood distillates," says Dr. Hunt. "It can confidently be predicted that the use of the synthetic methanol as a beverage or as an adulterant will be followed by the same disastrous effects to life and vision as have characterized such uses of wood alcohol. Those who are circulating the report that the synthetic methanol is not poisonous are not only stating an untruth but are assuming a grave responsibility, for death or blindness will inevitably be the fate of a number of those who may be misled by such statements and attempt to use synthetic methanol as a beverage."

As a result of his experiments on animals, Dr. Hunt finds that small doses of either methanol or ordinary wood alcohol are not as poisonous as the same amount of ethyl, or grain alcohol; but when the doses are repeated a few times at 24 hour intervals, the methanol has the most harmful effect. This is because the animal develops a tolerance to the ethyl alcohol. Methanol, however, works differently, as it has a cumulative action, a number of small doses having the same effect as a similar amount given at once.

Man, however, is sensitive to both, and, according to Dr. Hunt, a small dose of methyl alcohol is more harmful than a similar dose of ethyl alcohol. "The more highly developed nervous system of man is more seriously affected by methyl alcohol than is that of the lower animals and permanent blindness has often been reported from single, sometimes small, doses of methyl alcohol, whereas such results are unknown in the case of ethyl alcohol."—*Science Service.*

POLAR AND NON-POLAR VALENCES AS APPLIED TO ORGANIC CHEMISTRY*

M. S. KHARASCH, UNIVERSITY OF MARYLAND, COLLEGE PARK, MD.

The student of organic chemistry, today, has to defend his beloved science against the combined attacks of his many scientific friends. He is told quite openly that organic chemistry is hardly a science—some of the friends go even a step farther, stating that if a person had any brains at all he would be a physical chemist. The organic chemist, they point out, cannot analyze his reactions mathematically, and therefore predict them accurately; he cannot coördinate the reactions of one class of compounds with those of another. A knowledge of organic chemistry, they conclude, involves merely the memorizing of a great number of reactions.

These statements can hardly be refuted, for organic chemistry today is merely a huge compilation of facts, a notation of the curious behavior of a large number of compounds. The number of these apparently abnormal reactions has become so large that the field of organic chemistry has become highly specialized—this specialization indicates the weakness of the whole structure. This weakness is primarily due to a lack of fundamental concepts. Thus, the organic chemistry of today still rests upon the theories of Kekulé, van't Hoff and Baeyer, with the extra trimming added by individual investigators to explain the facts of their own particular fields. As a matter of fact, a large number of us have even developed an enthusiasm for discovering abnormal reactions and it is with great glee that we tell each other of some nightmare of chemical metamorphosis. Such nightmares are of fundamental importance only when they help us to expand our present-day concepts; not when they merely load our already sorely burdened literature with more unexplained reactions. What organic chemistry needs today is "an increased sense of perspective—a grasp wide enough to visualize and coördinate all lines of chemical knowledge" and I firmly believe that the electronic conception of valence is a step in that direction.

It is the electron that allows us to put a *soul* into the teaching of organic chemistry. The modern texts merely tax the student's mind to remember as many facts as possible. Most of them, particularly the elementary texts, show no critical faculty but consist merely of a repetition of the old statements (most of them not rigidly true or not at all true), and prove most conclusively the utter lack of a fundamental concept. The books are dogmatic and offer no answer as to *why* a reaction takes place, or how one reaction relates to another that has been previously discussed. If there is chaos in any science, it certainly exists in the science of organic chemistry.

* Abstract of paper delivered before the Division of Chemical Education, American Chemical Society, at Baltimore, April 8, 1925.

It is high time we realized, in view of the large number of unexplained organic reactions that our fundamental concept is at fault. Consider the simple Hofmann rearrangement. An amide, when treated with bromine and potassium hydroxide gives an amine. The student gasps—it is so hard for him to comprehend this change. *Why* does the reaction take place? No answer can be forthcoming unless one employs the electronic conception of valence.

It seems to me that in this day, when it has been so conclusively proven that everything can be resolved into electrons and positively electrified particles, there ought not to be the slightest hesitation in applying these discoveries in framing a theory of organic chemistry.

Such an attempt was made about ten years ago by Falke and Nelson, Jones, Stieglitz and a number of others, in the assumption that atoms in organic molecules, similarly to inorganic, are held together by electrostatic attraction. This interpretation of organic reactions was vastly superior to the older viewpoint, for it provided us at once with a driving force for chemical reactions. Thus, in the Hofmann reaction just quoted, the latter theory specifies that the instability of the molecule is due to the presence of a positively charged bromine atom which tends to go over into its stable negative form.

The difficulty with the completely polar theory is that it offers no adequate explanation of the vast differences between organic and inorganic compounds and that, excepting the phenomenon of directive adsorption, it does not explain the behavior of organic molecules. For instance, upon this basis, it is hard to see why there should be such a vast difference in chemical properties between primary, secondary and tertiary alcohols and also among the various aldehydes. Why there should be a difference in the reactivity of different types of compounds containing double bonds; or the difference in stability of various halides; or why, of all the acids, only the tertiary acids should evolve carbon monoxide; why heat is generated in reactions, etc., is not explicable on the basis of that theory. The only advantage the polar notion has over the Kekulé theory is in that it suggests an electrical force as the agency binding atoms in molecules.

Nor is the completely non-polar theory satisfactory or helpful to the organic chemist, for countless objections can be raised against it. However, the combination of the two theories in the sense originally suggested by Stark, namely that atoms are held together by shared electrons, when properly elaborated, becomes a very powerful tool. I am referring to the Lewis extension of the Stark idea, namely that the pair of valence electrons shared by two atoms may occupy varying spatial positions with reference to the atomic nuclei, depending upon the respective affinities of the two atoms for electrons. This beautifully logical concept is all the organic chemist needs to accept in order to gain an entirely new insight into the

field of organic chemistry. Organic chemistry then becomes a much more beautiful and fascinating science, for it rests upon a firmer foundation, and the numerous abnormal reactions become quite normal from the standpoint of the new concept.

It must, however, be stated that considerable caution must be exercised in the interpretation of organic reactions from this new standpoint. Thus, I believe, Lewis himself makes a very grave error when he attempts to explain the increase in the strength of monochloroacetic acid by assuming that the chlorine atom attracts the electrons toward itself, making the hydrogen more positive. If this interpretation were valid, chloroethylene, when treated with hydrogen chloride, by the same line of reasoning, should give dichloroethylene and not ethylidene chloride, which it actually forms. This, however, does not invalidate the fundamental concept; it merely shows that the organic chemist must look to someone well familiar with the field of organic chemistry for the theory necessary to the interpretation of his reactions. I am sorry that the time at my disposal does not allow me to demonstrate more thoroughly, by concrete examples, the superiority and vast advantages from the theoretical standpoint of the theory of partial polarity in the interpretation of organic reactions.[1] Anyone familiar with the field, however, who cares to apply this concept will find, as I have, a rich reward in a broader outlook and a more thorough appreciation of the science. He will also have little difficulty in correlating a large number of physical constants, on the basis of the electronic structure of the organic molecules.

Personally, I like to think of the discarding of all of our old pet theories of organic chemistry, "the old foundations of the science," and the adoption of the theory of partial polarity as a real victory for the organic chemist. It is strikingly associated in my mind with a passage from Barry's "Sentimental Tommy." Tommy and another boy were wrangling as to whose household amounted to more. Tommy had been having the upper hand right along, and finally in sheer desperation the other boy said, "Yes, but my father was once to a hanging." Quick as lightning Tommy replied, "Yes, but it was my father that was hanged!"

And so we organic chemists perhaps will have to hang our "fathers," our most fundamental views at the present time, but in adopting this course and the really revolutionary theory of partial polarity, we shall gain, like Sentimental Tommy, in prestige, for we shall live to see our beloved subject really become a science.

[1] This will be done in future articles.

FINDING AND SALVAGING THE SUPERIOR STUDENT

B. CLIFFORD HENDRICKS, UNIVERSITY OF NEBRASKA, LINCOLN, NEBR.

"If we think of a hundred college freshmen, chosen at random, and match the extremes against each other, 5 at one end can do more than 5 times as much as 5 at the other end. The next 5 at one end can do more than 4 times as much as the next 5 at the other end. The next 6 at one end can do more than 3 times as much as the next 6 at the other end. The next 9 at one end can do more than 2 times as much as the next 9 at the other end." [1]

As administered in many of our institutions the five at the upper extreme of the above distribution are pushed on at the year's end with a grade of 100 and a smug feeling of perfection in the course because they were permitted to loiter over a content fitted to meet the average of attainment of the class. The school has actually succeeded in "discouraging initiative, cutting the wings of imagination, lowering ideals, and recognizing inferior standards so that the superior student comes out from the system not much different from the inferior." [1]

"The democratic ideal in education, as everywhere else in life, is not equal distribution to all, but equal opportunity in proportion to capacity. The genius and the moron do not have, quantitatively, the same rights to knowledge; they have equal rights in proportion to their capacities (quantitative and qualitative), and one should be as insistent upon his rights as the other." [1] In an attempt to approximate this ideal the students in the beginner's chemistry course[2] in the University of Nebraska were divided at the end of the first month's work in 1923–24 into three groups; "C," a superior group, including all students who had an average first month's grade of 85 or above; "A," an inferior group whose average was 65 or less, and "B," an intermediate group for those whose achievement rating placed them between those limits. Such a sectioning divided each 100 of our 400 students roughly into one "C" section of from 30 to 35 students; two "B" sections of from 25 to 30 students, and one "A" section with from 15 to 20 students. For the "A" and "C" sections we selected our most experienced instructors.

To the "A" we gave three hours of class or quiz work per week instead of two which the other groups were receiving. They were treated, so far as methods of instruction were concerned, very much as high-school students. Since the group was small and the time greater, each student received practically three times the personal attention he would have otherwise had. If he didn't study it was not because of lack of stimulus. Work with this group was largely drill. 'Twas not inspiring, to an instructor, to say the least.

[1] C. E. Seashore, *Sch. and Soc.*, **15**, 353–8 (1922).

[2] For students with less than two semesters of high-school chemistry.

The students of the "C" or superior group were credited with ability to get the general principles of the subject largely from the lectures. Class time was given, not to memorization and drill, but to exercises of application, to an increased subject content, reports of library readings and the more inspirational features of the subject.

The "B" or intermediate group of students were given our usual or traditional treatment, three lectures, six hours laboratory and two hours class or quiz time per week. The subject matter covered was the usual material, comparable with the first half of that outlined by the Committee of Chemical Education of The American Chemical Society[3] but developed in a somewhat different order.

Statistics were not kept upon this first year's experiment so no quantitative estimate can be given of its results. Those of us most concerned felt, however, that the plan should be continued another year. It was the opinion of those who worked with the "A" and "C" groups that it was a misfortune to wait until the end of the first month to make the division; that this should have been done when the laboratory and quiz sections were first made up in the fall, for two reasons. The severest criticisms received from students were aimed at being required to change quiz masters during the semester. Then, too, many of the weaker students were so far swamped by the end of the first six weeks that more personal attention did not prevent their failure. If their probable difficulties had been known from the start they might have made a bare passing grade, or better, in the subject.

The result was that, in coöperation with the University Department of Psychology and the University's Extension Division, the alpha army test was given 313 of our beginning chemistry students during the first lecture hours of the first semester of 1924–25. These papers were rated, ratings recorded, laboratory desks assigned and quiz groups made up from these ratings so that from the very first laboratory period the student knew his full chemistry class and laboratory schedule including rooms, quiz masters and all.

By grouping all students with an army test rating of 100 or less in a low group and all with a rating above 150 in a superior group the course was organized as follows:

Section		Students	No. of sections
"A"	(students with army test rating 100 or less)	59	3
"B"	(students with army test rating 100–150)	163	8
"C"	(students with army test rating above 150)	91	3

The record for the "A" or low section shows that at mid-semester 74 per cent of all delinquents were from this group. At the end of the year 26 per cent of all delinquents were from this group. Of all students drop-

[3] THIS JOURNAL, **1**, 93 (1924).

ping the course before the semester's end with a grade D (delinquent) 76 per cent were from this group. Of the 59 low section students starting at the semester's beginning 46 per cent were delinquent at its end and but two or a trifle more than 3 per cent were so qualified by their excellent work as to be excused from the final examination.

On the other hand the "C" or superior group could be credited with but 10 per cent of the mid-semester delinquency or had but four per cent of its own number in that list. At the semester's end they had but 8 per cent of the delinquent group from their number and not one student from their sections had dropped the course with D. On the other hand this group furnished 80 per cent of all students excused from the final examination. Remember, this was done in the face of the fact they had studied more topics, had had less drill and had to pass harder monthly examinations than the other groups.

From the above data it might seem that the extra drill and extra one hour per week of class work had not accomplished much for the "A" section. Especially when the records showed that 46 per cent of the students so favored were practically failures in the course. Yet an investigation of these same individuals who repeated the course this spring shows that 92 per cent of them did creditable work. This is a better showing than usual for repeaters and I believe it reflects the result of their training in the "A" sections of the previous semester.

Our experience with the army test, as shown above, was more satisfactory than we had expected. It, in a large measure, met the difficulties of the year before, *i. e.*, prevented organization disruptions and located our probable failures. There has recently appeared, however, an even more satisfactory type of "placement" test than this. Under the direction of the National Research Council, Dean Seashore and some associates of the University of Iowa have worked up what are called chemistry placement tests.[4] These are of two kinds, one for "Aptitude," designed for students with no previous work in chemistry, and another for "Training" for those students with the traditional high-school chemistry course. These tests have, at least, one advantage over the army test—they serve as an introduction to the course. They remind the student of some essential prerequisites for success in chemistry and indicate the general character of the activities which will be included in the course. In other words, this test fits into the content of the chemistry course much more naturally than does the army test. The student recognizes it as a logical part of the course.

Through a survey[5] carried out in the spring of 1924 (in coöperation with Doctor C. S. Hamilton), it was found that about 26 per cent of the colleges

[4] C. E. Seashore, *Sch. and Soc.*, **20**, 515 (1924).

[5] Forthcoming article in THIS JOURNAL.

and universities which participated in the survey were using some form of sectioning based upon either ability or achievement. Chemistry departments in 35 per cent of these schools expressed a sympathy with the movement. In all cases except one, where the plan was under trial, satisfaction with the results secured was reported.

In the chemistry department of the University of Nebraska, all instructors who have had "A" or "C" quiz groups, have voted, without exception in favor of a continuance of the plan, in spite of the added work which its administration entails at the beginning of each semester. They feel that its use is almost wholly helpful to both of the extreme groups, "permitting them to make progress both in quantity and quality at the natural limit of their capacity for successful achievement."[7] In the words of one, "if only for the benefit of the superior student, let's continue it."[8] and another says, "It is from the superior section that the chemistry majors will come."[9]

[7] C. E. Seashore, *Sch. and Soc.*, **17**, 29–35 (1923).

[8] Personal communication, Doctor C. S. Hamilton, University of Nebraska.

[9] Personal communication, Doctor Lila Sands, University of Arizona.

France Celebrates Centenary of Photography Inventor.—Joseph Nicephore Niepce, who made the first successful, although crude, photograph at his home near Chalons, France, about a hundred years ago, will be honored by scientists from all parts of the world attending the International Photographic Congress. The French government has voted officially to recognize the work of this early worker who spent a large fortune to find a method of permanently fixing the image of the camera lens, and died too soon to see the results of his work.

In the sixteenth century Baptista Della Porta, an Italian, described the "camera obscura," which came into wide use as an aid to drawing, in his book "Natural Magic." This was similar to the camera of today which forms an image of the scene in front of it on the ground glass focusing screen; and by placing paper over the screen, the image could be traced. But for years a way was vainly sought to fix the image without the need of actually drawing the lines. Niepce found that a mineral pitch, called "bitumen of Judea," was soluble in oil of lavender, but became insoluble when exposed to light. He coated a metal plate with the bitumen, exposed it to light beneath a line drawing and then washed the plate with oil of lavender. The parts that had been covered by the lines were dissolved away, exposing the metal at these places. This same principle is still used to produce the photo-engravings which illustrate magazines and newspapers.

This did not satisfy Niepce, and a year later he produced a photograph by exposing a similar plate behind a lens, and thus produced the first known authentic photograph. The subject was a prosaic pigeon house in the rear of his home, and the exposure took many hours, but crude as it was, it was the herald of the time when every man, woman and child is able to take snapshots. A few years later, Niepce entered into partnership with Louis Jacques Daguerre, but he died in 1833 and so did not live to see the first daguerreotype, which was made in 1839, and was the earliest commercially successful photographic process.—*Science Service.*

WHAT DO PUPILS KNOW OF CHEMISTRY WHEN THEY BEGIN TO STUDY IT?

STEPHEN G. RICH, VERONA, N. J.

This paper is a report on the first stages of an investigation which, it is hoped, may be carried considerably further, and extended to sufficiently large numbers of schools and pupils to discover the typical and most frequent situations. Nevertheless, the results from the few cases already in hand are of sufficient interest and suggest enough points at which we may improve our instruction, to warrant the presentation of these more or less preliminary data.

That pupils know something about chemistry when they come to study it is well known to every teacher of the subject. That there is an immense variability in the extent of this knowledge and that it is mixed with misinformation, is equally well known. The questions here raised are: What do the pupils know? How great is the variation in their chemical knowledge? and, What misinformation do they possess? The method used for securing answers to these questions was the use of standardized tests upon pupils during the first week of their study of chemistry. The high schools at West Hoboken and Bloomfield, N. J., both within the metropolitan district and serving two widely different types of population, coöperated in the testing in 1925, with their February beginners as subjects. They did this, not out of any kindness to the investigator but because he had convinced them that the results would be of use to the instructors who were to teach these classes.

The Rich Test Epsilon, of the series published by the Public School Publishing Co., was used in both schools. At West Hoboken the pupils were also tested with the Bell test. In both schools and with both tests, the time-allowances were found far too long for beginners: eighteen minutes on the Rich test and twenty on the Bell sufficed for the best-informed and the slowest alike to do all they could on these tests.

What do the pupils know of chemistry? Every pupil tested knew at least one item on the Rich test correctly—though not always the same item. The average at Bloomfield was 4.35 items and at West Hoboken 5.07 items. These are out of a total of 25 items in the test. This amount of chemical knowledge or attainment is somewhat above that of the failing-pupils at the middle of a school year of chemistry, and approximately the same as the lowest scores made by any pupils on this series of tests at the end of a year's study of the subject. When turned into statistically corrected T-scores, the average for beginners fits into the curve of means of attainments: that is, if we extend the curve downward to "no time" of studying chemistry, plotting it from the norms established for every quarter-year on previous testing, the average of these two schools' beginners will fall on this curve.

More specifically, the following are the items correctly known within the Rich test: for convenience it may here be stated that 17 pupils (12 girls) were tested at Bloomfield and 26 pupils (8 girls) at West Hoboken.

Test question 1, as to why green leguminous manure and application of Chile saltpeter have similar effects upon fertility of land: Bloomfield 11, West Hoboken 20 correct.

Test question 4, as to starch being the constituent common to tapioca, rice, etc. Bloomfield 15, West Hoboken 22 correct.

Test question 5, as to cause of disinfectant power of hydrogen peroxide. Bloomfield 7, West Hoboken 15 correct.

Test question 14, as to material causing the Solvay process to be carried on at Syracuse, N. Y., instead of elsewhere. Bloomfield 3, West Hoboken 12 correct.

Beyond these four items the correct responses were very scattering. Every question save two in the test was answered correctly by at least one pupil; at Bloomfield 6 questions were not answered correctly by anybody, and at West Hoboken only one was entirely missed. The entirely missed item is a calculation involving an equation. Of the items outside the four fairly well known ones, none got over 6 correct responses at Bloomfield or 8 correct at West Hoboken.

It is of interest to note the numbers of pupils responding to the questions, irrespective of the correctness of their responses. For the four fairly well known items the total responses were:

Question	Bloomfield	West Hoboken
1	14	23
4	16	25
5	16	22
14	6	20

We next come to the question of the variability of the beginners with respect to chemical knowledge. At Bloomfield the highest number of correct responses given by any pupil was 11; the second highest 9; then one with 6, and all the rest with 5 down to 2 correct. West Hoboken had one with 13 correct, one with 11, three with 8, and the rest from 6 down to 2 except for a lone girl with only 1 correct response. The means, as mentioned above, were 4.35 for Bloomfield and 5.07 for West Hoboken.

Now the published norms for this test show that after half a year of instruction in chemistry the mean score of pupils on this test was 10.5 correct responses; at the end of a year the mean is 13.1 correct. Thus, it appears that there is a range of chemical attainment among beginners extending up almost to the average at the end of a year's instruction in high school. This variation is entirely uncared-for in our instruction and may be labeled

at once as a cause of great waste of pupils' time. It is beyond the province of this paper to suggest how it may be met in school organization and in class teaching.

The misinformation which pupils bring to chemistry was also shown by the results with the Rich test. For example, at Bloomfield, question 5, discussed above, was answered by 16 out of the 17 pupils; but only 7 answered it correctly. At West Hoboken, the misinformation was considerably less widespread, as shown by 15 correct responses out of a total of 22. Some further cases of misinformation, including all the conspicuous ones, deserve listing at this point.

Test question 3—Bloomfield, 6 responses, none right; West Hoboken, 16 responses, 3 right. This is a question involving the finding of a formula when valences are given.

Test question 7—Bloomfield, 15 responses and 3 correct; West Hoboken 23 responses and 5 correct. This is a question as to the cause of the action of a gas-mask, with adsorption as the correct answer.

Test question 10—Bloomfield, 17 responses and 4 correct; West Hoboken, 24 responses and 8 correct. This is a question as to what essential to combustion a hand fire-extinguisher removed.

Test question 12—Bloomfield, 14 responses; West Hoboken, 20 responses; none right in either school. This is a question on replacement of mercury by copper, from a solution of a mercuric salt.

Test question 19—Bloomfield, 13 responses and 6 correct; West Hoboken, 20 responses and 1 correct. This is a question on the cause of osmosis.

Test question 20—Bloomfield, 10 responses and 1 correct; West Hoboken, 15 responses and 1 correct. This is a question as to what causes the taste, slippery feel, etc., of basic hydroxides.

Test question 25—Bloomfield, 9 responses and 1 correct; West Hoboken, 15 responses and 2 correct. This is a question requiring the common name for mercuric chloride.

The prevalence of misinformation is more extensive than these conspicuous cases would indicate. In only 10 of the 25 questions were the total numbers of responses markedly smaller than would be, and regularly have been, secured from half-year and full-year classes in chemistry. Thus, the misinformation in the less conspicuous cases mounts up to at least as much as that in those exhibited above. That much of this is ignorance rather than misinformation may well be held; but ignorance tempered by a shade of information sufficient to enable even a guesser to make a response is really to be classed as incorrect information or misinformation.

With the Bell Test the situation revealed at West Hoboken was essentially the same as that revealed with the Rich test. Owing to its more technical

content, the total responses and the correct responses alike fell lower than with the Rich test.

The Bell test is scored on a basis of 100 points, 4 for each question of the 25 forming the test. Partial credits are given for partly correct answers except where such answers cannot fulfil the purpose of the question. The West Hoboken beginners had a mean point-score of 8.7, with a range which included one pupil with 25 points, one with 23, one with 20, one with 14 and so on down to zero. Two boys and a girl made zero scores on this test. That such scores do not mean zero knowledge of chemistry may be inferred from the fact that, in an article to be published elsewhere, I have shown that the zero-point for this test is minus 10 points. That is, if made into a true scale with a true zero, all Bell test scores should have 10 points added to them.

The specific information and misinformation revealed by the results of the Bell test are interesting. The highest number of points made by the 26 pupils was on question 8, where they piled up 39 points in all. This is an average of 1.5 points per pupil. The question calls for naming four processes for purifying water; only two pupils named four; only 6 named none at all; only 2 named entirely irrelevant processes.

Question 2, as to what gas is given off when yeast acts on dough, secured 32 points in all, with 8 correct answers, 6 incorrect ones, and 12 omissions. Question 16, as to whether air is a chemical compound or a physical mixture, also secured 32 points, with 8 correct responses. But 16 pupils answered this incorrectly!

Question 6, requiring oxidation to be defined, was answered correctly by 3 pupils, partly correctly by 6 more, getting 26 points in all; 5 wrong responses were given. Question 14, on the two most abundant elements in the atmosphere, secured 24 points from 6 responses: this question is scored as all right or all wrong. But 14 pupils gave wrong responses, mainly consisting of mentioning carbon dioxide and some component other than oxygen and nitrogen.

Beyond this point, the correct responses were few and limited to a few questions. Twelve questions got only incorrect or partly correct responses, but every question was answered by at least one pupil in some way or other.

In addition to the misinformation as to the elements found in the air and the nature of the atmosphere, two other misconceptions showed up. Question 3, on naming two chemicals used in making oxygen, was answered by 14 pupils, with 2 points of correct response in all. Question 11, asking for two common organic acids, was answered by 16 pupils, without a single correct or partly correct response. Hydrochloric acid was the one most commonly named; sulfuric acid the next.

The data thus far presented indicate the actual chemical knowledge displayed by a small number of beginners in chemistry as well as the amount

of misinformation they had previously acquired. They show that among beginners the fund of general chemical knowledge ranges from the equivalent of a full year's instruction to a few vague chemical notions, and they show the immense amount of misinformation with which most beginners undertake the study of the subject. It remains now to inquire into how they come by this information and misinformation.

Approximately half of each group studied (but not either the best or the worst half) had had either biology or physics before beginning chemistry. Nearly all had had a course in general science anywhere from two to four years previously. What the tests exhibited was the "mental precipitate" of these courses in general science and special sciences, so far as they overlapped into the chemical field. Much of the confusion must, I think, be laid at the door of biology; though as a past teacher of biology as well as of chemistry, I am prejudiced against allowing such blame. Biology emphasizes, for example, oxygen and carbon dioxide in the atmosphere; this is perfectly legitimate, but is not conducive to giving pupils the proportionate necessary idea of the importance of nitrogen. A recent paper in *School Science and Mathematics* shows that on osmosis the biologists are in hopeless confusion, not differentiating osmosis and diffusion, not clear as to the physical chemistry involved, and not even biologically clear in their applications of osmosis.

In the attempt to simplify the content of general science to the point at which it could be grasped by 8th and 9th grade students and at the same time to cover a large range of material, the treatment of almost every topic has been so skeletonized that there is not left sufficient information to enable the pupil to correctly answer questions on the same subjects as worded in chemistry tests. Thus, in the purification of water, the general-science teaching does not appear to have given the pupils more than two methods or processes in most cases; in the question on the fire-extinguisher the factors and process involved in extinguishing do not appear to have been made clear.

I hasten, however, to defend both the teachers of biology and of general science. Dr. Powers has recently published data as to the amount of retention of information in chemistry at various intervals after the completion of a high-school course in this subject and there is every reason to believe that the comparatively rapid loss which he finds is typical of teaching in almost every high-school subject, from Latin and history to biology and shorthand, except where and when this knowledge is kept in active use. A reasonable stand would be to apportion the responsibility for the confusion and misinformation in approximately equal parts between the teachers of other sciences and the pupils' ability to forget what has been taught them.

It may be of interest that the West Hoboken class of beginners, tested

with both Bell and Rich tests, showed a correlation of 0.316 ± 0.10 between the ratings of its members by the two tests. This is slightly less than the correlation which the same pair of tests shows for pupils at half or three-quarters of a year of instruction. The significance of the correlation in the present study is the evidence that it offers that the two tests measure markedly different phases of chemical achievement; thus the results from the two tests are of independent value in showing what pupils do and do not know at the beginning of their chemical instruction.

A rather curious sidelight is thrown on the level of attainment of pupils by a class of three-quarter-year pupils recently tested with the Bell test in one of these schools. This class, which consisted of pupils who did not intend to take any college-entrance examination, and who were taking chemistry simply to make up a science-requirement for graduation, without any interest in the subject other than what the teaching could generate, had as its mean score on the Bell test 31.0 points, with a range from 12 to 51. It will be recalled that the beginners ranged from 25 down to zero. Over a fourth of the beginners were within the range of attainment of this "dubs' class."

The present study is, as mentioned earlier, to be extended by increasing the numbers of pupils tested; but it is not the intention to use the Bell test further. Its excessively technical content, the language-ability which it calls for in addition to chemical information, and the fact that my edition of it is entirely exhausted, will prevent this. Results from some four to five hundred beginners, in at least two dozen schools in the metropolitan district, are sought. Some further future extensions of this work, which may well be carried out by others are: the relation of initial chemical attainment to intelligence-level; the relation of initial attainment to rate and amount of progress during chemical instruction; similar studies on beginners in physics or in biology.

A special further extension, and one of great value in view of the strictures of college teachers on high-school teaching of chemistry, is the determination of the initial chemical attainment of those who begin the study of chemistry in college. Naturally, one would test the high-school trained pupils who take the same freshman course, at the same time; and it is safe to prophesy that there will be found many among them who have forgotten enough in the three or fifteen months since they finished high-school chemistry to place them justly as beginners once more, even though they have entrance credit for chemistry.

Memorandum on Caring for the Range of Variation in Initial Attainment

In order not to confuse the paper, I have deliberately excluded the question of caring for the range of variation of attainment of beginners in chemistry. The solution is perfectly simple in a large high school, and

in fact, in any school where there are sections of the class at different hours in chemistry and in at least two other subjects which the students taking chemistry also take.

One need only make a ruling that, for instance, all the pupils in the lower half of the class in initial attainment as measured by the test must take chemistry in one period and those in the upper half must take it in the other. With three or more sections a somewhat better grouping can of course be made. Furthermore, those pupils who are up to the half-year norm or above it, should not be put through the first half year of chemistry, but put at once into the second half-year's work. This will mean that they get credit for only half a year of chemistry; but there is no reason why they should not make up any graduation requirement with half a year of physics. If college entrance is involved, the examinations take care of this matter of time credits.

In some large schools in New York City, the way is even easier. One school for example, gives both a year of college entrance chemistry and a year of "Chemistry of Everyday Life," with a special course for the pupils out of the latter who want to pass college-entrance requirements. This special half-year or "X" course as it is there called, offers a good solution to the difficulty of providing a full year's work for the pupil with high initial attainment. Let him take the second half of "Chemistry of Everyday Life," then the "X" course, and he is well trained, with a full year's credit.

The chief opposition that may be expected to such schemes is due to two causes. First, administrative officers and chemistry teachers alike are apparently loath to provide and enforce any scheme of segregation by compelling certain groups of students to choose certain periods. Most high schools, for some unknown reason, will let any student take his initial course in chemistry at any hour, in any section that happens to be offered. Thus every section is a mixture of initially informed and initially ignorant pupils, of bright and slow, of willing ones and shirkers. This, I submit is not just to either pole of any of these contrasts. The other objection that will be made is that standardized tests are not sufficiently accurate measuring instruments for us to rely on them in practical school work. The answer is that there is abundant evidence that the worst and least efficient standard test in any subject is more efficient than the best old-style examination and more efficient than the judgment of 9 out of every 10 teachers. It is only because the tests measure against criteria which are not yet accepted by chemistry teachers that they are not seen to be efficient. The Rich tests, for example, attempt to measure chemical attainment that is directly relevant to the 7 aims of education as set forth in 1916 by the N. E. A. Most chemistry teachers have not yet come to know—much less to accept—these aims; they have therefore no basis for condemning the

tests. If we wait until tests are perfected, we shall wait forever; but now, in 1925, there are tests in chemistry sufficiently better than any other modes of judging pupils to warrant their use, with reliance upon the results.

American Children Claimed More Intelligent than Chinese. Intelligence tests recently conducted in San Francisco public schools show American children to be superior to Chinese children in the matter of intelligence, says Virginia T. Graham in her report of the tests to appear in the *Journal of Comparative Psychology*.

The Chinese children used as subjects for the tests were all pupils of the Oriental School of San Francisco, a public school exclusively for Chinese. Only about one-fifth of the children tested were born in China, but all were of Chinese parentage and came from Chinese speaking homes. The majority were Cantonese.

The subjects were all twelve years old and as practically all of the twelve year old children in the school were tested, the group was reasonably representative.

Several different types of standard mental tests were used and in so far as possible tests were selected which would not likely be affected by the difference in language. These same tests had been given previously to a group of American children and the results recorded.

In almost every test given the American children proved to be superior to the Chinese children. It is interesting to note, however, that the Chinese children did show a better ability to remember objects that had been seen in the visual memory test. On the other hand, the American children had a better score in the auditory memory test in which the children were asked to repeat sentences and numbers which had been read to them.—*Science Service.*

Tuberculin Test Defended by Government Expert. "Without the aid of tuberculin it would be absolutely impossible to attempt to control tuberculosis in livestock," said Dr. J. A. Kiernan, chief of the tuberculosis eradication division of the U. S. Bureau of Animal Industry, when he was asked whether the accuracy of this method of testing is in doubt. "Before use of tuberculin became general," Dr. Kiernan stated, "physical examination of cattle was depended upon, but it proved futile in freeing herds of the disease.

"The same percentage of accuracy is shown by tests now as was found more than 30 years ago when tuberculin was first used for the purpose of diagnosing tuberculosis in cattle," he continued. "Of more than 20,000 animals that reacted to the tuberculin test during June, 1925, 92 per cent showed positive lesions of tuberculosis on the ordinary post mortem examination. Many more of those animals would have shown lesions had a more thorough search been made. Furthermore, laboratory examinations of the tissues of the animals that showed no lesions would reveal at least one-fifth of them to be tuberculous. In some of the states where thousand of reacting animals are slaughtered, cases showing no lesions are less than three per cent, thus indicating a very high degree of accuracy for the test."

Dr. Kiernan pointed out that the campaign for eradication of tuberculosis in livestock is going on in every state, and that it is purely voluntary work, carried on under state laws and regulations. No owner is required to submit his herd to the test except in areas where at least 75 per cent of the other cattle owners have their herds tested.

During the fiscal year 1925, 7,000,000 cattle were tuberculin tested in the United States.—*Science Service.*

TRAINING FOR THE PROFESSION OF CHEMISTRY*

M. L. CROSSLEY, CALCO CHEMICAL CO., BOUND BROOK, N. J.

The profession of chemistry is second to none in importance. The training for the profession must be thorough and uniform. The course of study must be strictly defined. There are definite courses of training for the chemical engineer and it is equally important that the training for the chemist should not be left to chance. A young man should know before he begins his study for the profession of chemistry what course of training is necessary. The basic training should be the same for all chemists and special training should be selected to meet the needs of the individual. The several branches of chemistry are so interdependent that no training is adequate which does not cover the fundamentals as a whole before specialization is permitted. In my judgment the minimum training for the profession of chemistry should be six years of study including two years of graduate work in some particular branch of the science. Only bare elementary principles can be expected in a four-year undergraduate course. A working knowledge of chemistry is essential for the understanding of chemical problems and a facility in thinking oneself out of difficulties comes from an added intensive training in graduate or professional schools.

A satisfactory course of study that trains men to think broadly and wisely in the application of the fundamental facts of chemistry to the solution of modern technological problems must include English, French, German, history, mathematics, physics, philosophy, psychology, economics, social science and biology. The training in English should be sufficient to enable the chemist to critically examine his data and express his results with such brevity, clarity and force as to carry conviction. The chemist is frequently expected to report to non-technical men and he should be trained in the art of presenting technical information in a language which is understood by the laymen without sacrificing accuracy and precision. He should be able to record his observations accurately and in an orderly fashion so as to be understood and evaluated by one unfamiliar with the details of the work. This kind of training in English should be the joint product of the English and Chemistry Departments in the University or Professional School. The course should be designed to meet the special needs of technical men and should be a requirement for the chemist.

A chemist must be able to read French and German technical literature readily. The results of many investigations are published only in the language of the country in which the work was done and much important work is reported in French and German technical journals.

To understand the conditions of the present and be able to anticipate

* Paper delivered before the Division of Chemical Education, American Chemical Society, Baltimore, Md., April 10, 1925.

the demands of the future a chemist must know something about the past. We of today have no monopoly of ideas. The history of the race is a record from which all of us can learn how men similarly constituted, aspired, fought against odds, won some victories, failed to accomplish their purposes, not infrequently, and made their exit, entrusting to us a heritage to be zealously guarded, enriched and passed on to posterity. We add a bit here, take away a little there, and the ball of knowledge rolls on, gaining in volume and momentum. This is particularly true in chemistry. The theories of old are the playthings of the chemists of today and will be the foundation stones in the scientific edifice of the future. No training for the profession of chemistry is adequate unless it includes the history of chemistry. The course in the history of chemistry should be designed to correlate and interpret the work of the past and to show the contribution of chemistry to world progress.

Chemistry is unintelligible without a good training in mathematics and physics. A course designed to train men for the profession of chemistry should include mathematics through calculus, and theoretical and practical physics. Chemistry and physics are indissolubly linked. It is difficult to say where one begins and the other ends. There is no better study to develop the power of observation than experimental physics. It cultivates an appreciation of the importance of facts and develops precision in the preparation of records. Such training is of inestimable value in the correlation of chemical data and in the interpretation of facts. Careless observation and faulty grouping of facts lead to incoherent thinking. Mathematics helps to quicken mental perception, cultivates and disciplines the imagination and aids in shaping judgment. It is indispensable to the chemist and the course of training for the profession of chemistry should include the application of mathematics to chemistry. Such a course should preferably be developed and taught by the chemistry faculty of the school.

Every professional man should have a knowledge of the fundamentals of philosophy, psychology, social science and economics. The chemist is not an exception. His professional and business relationships are such as to call for special extension and elaboration of the principles of ethics and logic. His success is often measured more by his ability to deal with men than by his knowledge of chemistry. Training in psychology and social science should help him to understand the conditions surrounding his work and make him a constructive force in society. The chemist must also have a better training in the fundamentals of economics and their application to business. This is particularly necessary for the industrial and consulting chemist. He must think in terms of costs, markets and profits. It is essential that he be trained to analyze and evaluate the elements contributing to successful business. The research chemist can also profit by such

training. Less misdirected effort, fewer false starts, and more gratifying results could be expected. Following the scent of truth, simply for the sake of experiencing the pleasure of momentarily possessing it, is a fascinating and laudable pursuit, but there are marked differences in the value of truths, and it is only common sense to go after that most worth while. No sane hunter will waste his ammunition on a sparrow when he has a chance to get a partridge.

A general course in biology should be developed for the professional chemist. This should give him a composite picture of the structure and functions of his body and an appreciation of the influences of environment on health and happiness. Any further training in biology should be given in connection with the special work of the graduate or professional school.

The best education for a chemist is that which fits him best to understand the problems of his environment; to most thoroughly appreciate human efforts and limitations and to enjoy the privileges of unselfish service—in short that which gives him the fullest acquaintance with life.

COMMITTEE ACCEPTS CHEMICAL ACHIEVEMENT EXHIBITS

Many of the leading entries for the Court of Chemical Achievement, to be held in conjunction with the Tenth Exposition of Chemical Industries, during the week of Sept. 28th to October 3rd at the Grand Central Palace, New York, commemorating notable discoveries and achievements in the field of American chemistry over the past few years, have been passed upon by the approval committee of the American Chemical Society and accepted for the Court. Dr. Marston T. Bogert is chairman of the Committee of Approval. All exhibits to pass the committee have been strictly of American development and notable in the field of chemistry or chemical engineering.

Some of the chief entries which have been accepted include: four colors and dyes, two rubber accelerators, duco, tontine, fabricoid, low freezing explosive, and a special shotgun powder, all by Du Pont; germanium dioxide made commercially, spectroscopically pure cadmium and zinc by the New Jersey Zinc Company; six new products from the Chemical Warfare Service; permalloy for high speed submarine cables by the Bell Telephone Laboratories; commercial metallic tantalum by the Fansteel Products Company; fibrin, haemoglobin, and serum albumin by the American Protein Company; catalytic oxidation of benzene to maleic acid and its derivatives by Weiss & Downs; tetra ethyl lead by the Ethyl Gasoline Corporation; crodon, a special plating alloy by the Chemical Treatment Company; bakelite by the Bakelite Corporation; 259 special organic chemical products by the Eastman Kodak Company; recent chemical development of special optical glass by Bausch & Lomb Optical Co.; chemical development of pyrex glassware by the Corning Glass Works; ethylene for coloring citrous fruits, fireproof fumigation of grain against weevils, and the preparation of invertase by the Bureau of Chemistry; thyroxin by the Mayo Foundation; karolith and its development from casein by the Karolith Corporation and others.

The Committee of Approval has a number of additional applications still under consideration which will probably be passed on in the near future. Several products which were rejected have been returned to the committee with additional data requesting reconsideration. Entries for the Court of Achievement are still being received at the Grand Central Palace offices of the Chemical Exposition.

THE NEED FOR RESEARCH ON PROBLEMS OF HIGH-SCHOOL CHEMISTRY INSTRUCTION

EARL R. GLENN, TEACHERS COLLEGE, COLUMBIA UNIVERSITY, NEW YORK CITY

Curriculum Reconstruction in Chemistry
Analysis of Articles on Chemistry Instruction
Are Magazine Articles Valuable Contributions?
Is There Any Continuity in Magazine Articles?
Functions of a Committee on High-School Chemistry Investigations
What We Do Not Know about the Teaching of High-School Chemistry
How the Work of a Committee on Investigations Might Be Started

As a result of the formation of a Division of Chemical Education in the American Chemical Society, there has been much discussion recently relating to the subject matter of high-school and college chemistry courses. An attempt is being made to formulate an outline for a minimum high-school chemistry course which will be generally acceptable to all persons concerned. At the Washington meeting (1924) of the American Chemical Society, a paper was read on "Problems Associated with the Construction of a High-School Chemistry Course." * This paper listed a few problems and mentioned certain pertinent facts related to each. In the discussion which followed, the Division of Chemical Education voted to appoint a committee to gather the opinions of the members with respect to the organization of a program for studying various phases of high-school chemistry instruction.

Curriculum Reconstruction in Chemistry

The Division has published a proposed syllabus for high-school chemistry which has been formulated as a result of extensive criticism on the part of interested chemistry teachers. Such a movement as this is desirable and in the present status of affairs, perhaps a committee judgment is the only method that can be used for the formulation of a more adequate high-school syllabus. However, there is a great gap between what ought to be taught and what is or can be taught, and these matters require actual evidence which no committee has had at hand.

The unique position occupied by the Division of Chemical Education and the influence its recommendations are likely to have, suggest that specific recommendations for state-wide adoption should be made with much more deliberation than has usually characterized committee reports. These comments are especially pertinent with respect to any syllabus which may become a fixed syllabus for all time to come. Such a possibility may seem remote at the present time, but the experience of teachers in certain states in which a chemistry syllabus is made the basis of all high-school courses, shows that once a syllabus is accepted, it is almost impossible to make any

* Glenn, Earl R., "Problems Associated with the Construction of a High-School Chemistry Course." Read before the Division of Chemical Education, Washington, April, 1924.

appreciable changes in it or in schoolroom practice based upon it. The main purpose of this paper is to suggest a line of work which should be developed to supplement, and in some instances to precede, committee judgment in the formulation of a high-school chemistry course.

A Brief Analysis of Published Magazine Articles Bearing upon Chemistry Instruction

A survey of the articles that have been written on the teaching of chemistry during the past twenty-five years, reveals the fact that most of these papers are of no importance now, and in all probability never were of much

TABLE I—THE LENGTH OF MAGAZINE ARTICLES WRITTEN UPON THE TEACHING OF HIGH-SCHOOL CHEMISTRY, 1890–1925

(Based upon 455 articles by 282 authors)

Length of article in pages, 1890–1925	Number of articles of this length	Per cent of articles of this length
1	27	5.9
2	136	29.8
3	73	16.0
4	40	8.8
5	40	8.8
6	37	8.1
7	29	6.4
8	18	4.0
9	18	4.0
10	9	2.0
11	14	3.0
12	3	0.7
13	4	.9
14	1	.2
15	1	.2
16	1	.2
17	1	.2
18	0	0
19	1	.2
20	1	.2
**	**	***
29	1	.2

consequence. Most of the papers are short, poorly organized, and show no careful study of the scientific or educational literature bearing upon the questions discussed. We do not need any more papers of this type. They are found in great numbers in the educational journals that are now on the shelves. What we do need and need greatly is a series of papers that result from intensive study of limited fields of high-school chemistry instruction.

Are the Magazine Articles Valuable Contributions?

In order to secure more specific information upon the nature of magazine articles dealing with chemistry instruction, we have recently made some

tabulations to reveal certain facts. A bibliography of 455 articles was compiled from the work of 282 authors for the years covering the period from 1890 to 1925.

We classified the articles according to length in pages, as shown in Table I and find that 6 per cent were one page in length; 30 per cent 2 pages in length; 16 per cent 3 pages in length; and 9 per cent 4 pages in length. In other words over 60 per cent of these articles were less than 5 pages in length.

We are not advocating longer magazine articles as such, because many of these articles could have been reduced to one short paragraph with no loss to future generations. We do believe, however, that the time has arrived when the short, miscellaneous articles of a professional nature should be very greatly limited in favor of reports that have been preceded by more thought, labor and consultation of the work of previous writers.

Is There Any Continuity in the Magazine Articles of Authors Who Discuss High-School Chemistry Instruction?

When one studies the facts bearing upon the number of articles written by individual authors who publish reports concerning high-school chemistry one is astonished to find that 73 per cent of them are "single-shooters" for 73 per cent of the 282 authors wrote only one article in the period from 1890 to 1925. Fourteen and one-half per cent of the authors wrote two articles and 4 per cent wrote three articles. Thus we discover that over 90 per cent of these authors wrote less than four articles in their chosen field of work.

TABLE II—THE NUMBER OF MAGAZINE ARTICLES WRITTEN UPON THE TEACHING OF HIGH-SCHOOL CHEMISTRY, 1890–1925

(Based upon 455 articles by 282 authors)

Number of articles written, 1890–1925	Number of authors who wrote this number of articles	Per cent of authors who wrote this number of articles
1	206	73.0
2	41	14.5
3	12	4.3
4	10	3.5
5	5	1.8
6	1	0.4
7	3	1.0
8	1	0.4
9	1	.4
10	1	.4
11	0	.0
12	1	.4

Unless a movement is formulated to stimulate the production of better papers bearing on professional problems, we are likely to have another generation of inadequately prepared articles for such journals as the JOUR-

NAL OF CHEMICAL EDUCATION. The schools of education are growing rapidly and recently several educational journals of a much better grade have appeared in the field. A few students in schools of education or in university chemistry departments are now engaged in studying, in an intensive manner, some of the problems of high-school chemistry instruction but only a beginning has been made. A few publications of the much-desired type are mentioned below:

1. Beery, Pauline C. "A Practical Course in Household Chemistry," *J. Educ. Research*, **5**, 125–34 (1922).

2. Cornog, Jacob and Colbert, J. C. "A Quantitative Analysis of Aims in Teaching High-School Chemistry," *Sch. Sci. Math.*, **24**, 168–73 (1924).

3. Gerry, Henry L. "College Entrance Examination Board Questions in Chemistry," *Sch. Sci. Math.*, **20**, 845–50 (1920).

4. Koos, Leonard V. "Overlapping in High-School and College Chemistry," Chapter 33, *The Junior College*, Vol. **2**, University of Minn. (1924).

5. Osborne, C. E. "How May Local Interest in Chemistry Be Increased?" *Sch. Sci. Math.*, **21**, 128–34 (1921).

6. Powers, Samuel R. "A Diagnostic Study of the Subject Matter of High-School Chemistry," No. **149**, Bureau of Publications, Teachers College, Columbia University (1924).

7. Stone, Charles H. "A New High-School Course in Chemistry," THIS JOURNAL, **1**, 233–8 (1924).

What Functions Could a Committee on High-School Chemistry Investigations Perform?

If the Division of Chemical Education had a standing committee to deal with problems of high-school instruction, it might serve as a clearing house for the definition of problems of investigation, and it might also assist in placing proposed investigations in various institutions. Individuals who might conduct such studies may be listed as follows: (1) graduate students in schools of education; (2) prospective teachers in college and university departments; (3) experienced teachers who find it possible to conduct an investigation by pooling the interests and labors of several teachers of chemistry in a given high school or city; (4) bureaus of research, state departments of education, and similar organizations that are frequently in a position to gather data or to supply workers with data.

What We Do Not Know about the Teaching of High-School Chemistry

In listing some titles no attempt is made to define the scope of the investigations specifically. This must be done with considerable deliberation. If this type of work is to be promoted, a committee should gather suggestions from the members of the Division and then formulate a program and list the studies most in need of attention. We mention a few examples:

1. What is the present status of chemistry in typical states and cities with respect to the per cent of high-school students enrolled; the adequacy of furniture and apparatus;

the teaching load; the combination of subjects taught; the science training of the teachers in service; and the chief sources of efficiency and inefficiency of instruction?

2. What are the present teacher-training facilities with respect to chemistry in typical states? If courses are given, dealing with the teaching of high-school chemistry, what do these courses include, and what should be included?

3. What is the cost of high-school chemistry instruction in typical schools of various sizes in various states and cities as determined by case studies in representative high schools?

4. Is the enrolment in chemistry increasing or decreasing in typical large cities and representative states?

5. Just what is the work of a chemistry teacher as shown by job analyses of his work including a study of the teaching load and a survey of the daily and weekly tasks? What ought to be the chemistry teacher's job?

6. What does it cost to install adequate furniture and apparatus for a chemistry course in the high schools of various sizes and types?

7. Has not the time arrived when a complete bibliography on the teaching of high-school chemistry should be compiled, annotated and published?

8. What are the major conclusions, reached in the chief studies of a scientific nature, that bear on the teaching of high-school chemistry?

9. What subject matter and methods of instruction are actually used by the best high-school teachers today? An investigation of this nature would require the presence of two teachers in the classroom during the entire time that a given class is being taught. One or two investigations of this nature, if published, might do much to put into the hands of prospective teachers a classroom technique that would be efficient. A comprehensive investigation of this nature would be expensive and would embody many details such as: (1) the actual time used in teaching the various topics of the course; the time devoted to laboratory work, demonstration work, and class discussion; (2) the functions of individual laboratory work and a careful study of individual successes and failures of the pupils; (3) the functions of the notebook and the cost of producing it; (4) the appreciational aspects of the course; (5) the distribution of drill upon difficult topics, general reference work and class excursions.

10. Has not the time arrived when a definite attempt should be made to stimulate the organization of new units of subject matter or better development of old units in high-school chemistry? This work is now being done in more or less haphazard fashion in several schools. If it could be organized so that several individuals could take part in the work, new units that have had adequate classroom trial could be published from time to time. Certain progressive teachers in various sections of the country are always engaged in this type of work. Others could be interested, and coöperative studies could be made.

11. Is it worth while to try to teach chemistry in the rural high school? If so, what kind of chemistry and under what conditions?

12. Are we in a position now to use improved methods in estimating the achievement of students (1) for high-school promotion; (2) for college entrance examinations and predictions of college success; (3) for studying the success of students in freshman college chemistry; (4) for studying the influence of age, ability and previous training upon the success in high-school chemistry; (5) for studying errors and remedial measures for instructional purposes?

13. To what extent can an average high-school chemistry pupil read and interpret typical paragraphs of American high-school chemistry textbooks? This problem is worthy of very thorough investigation, especially from the point of view of the students of low ability.

14. What constitutes the technical vocabulary of high-school textbooks and laboratory manuals?

15. What system can be devised for making sure that pupils learn to spell the necessary technical words in high-school chemistry?

16. Has the time not arrived for the production of standardized practice exercises which have been carefully studied with respect to time and difficulty? These practice exercises are needed especially for poor students for the essential equations, typical problems in chemical arithmetic, symbols, properties of substances, and many other topics.

17. What is the legitimate function of popular reading in a high-school chemistry course? How much time can or should be devoted to it?

18. What publications of manufacturing firms are now in existence that contain explanations or diagrams that would be useful in a high-school course? Would typical manufacturing firms be willing to prepare a brief resumé of the chemistry of the essential processes and publish pamphlets for high-school use?

19. Do we not need a critical study of the function of moving pictures in chemistry instruction?

We have mentioned only a few problems that come to mind in this field. There are others that will occur to the reader. We shall be glad to receive any comments or suggestions from those who have specific problems in mind which are worthy of the attention of the committee.

How the Work of Such a Committee Might Be Started

We propose the following plan for discussion: The committee would compile from its members and from members of the Division of Chemical Education a list of problems bearing on high-school chemistry instruction. This list should then be printed in the JOURNAL OF CHEMICAL EDUCATION and be made the basis of discussion through the JOURNAL, by correspondence, and perhaps by means of papers at some of the meetings. When a thorough-going discussion has enabled the committee to define some problems specifically, a selection could be made of those most in need of attention. A movement could then be inaugurated to distribute these problems to those interested in doing the work. This could be done by distributing reprints of the committee's reports to chemistry teachers, to college and university chemistry departments, to professors of secondary education, and to organizations of chemistry teachers. State departments of education are very frequently interested in work of this type and a limited number of research departments in certain cities might be interested.

From time to time the committee could publish a report of progress, giving the names of the various investigators and the present status of the work. When the studies are completed, they could be reported before the Division of Chemical Education and published in the JOURNAL. The chief conclusions from these studies should be very carefully considered by another committee of the Division of Chemical Education and from time

to time this group should make specific reports or recommendations concerning ways and means of improving high-school chemistry instruction.

Summary

This paper considers the committee procedure inadequate when used as the sole method in developing a syllabus for a high-school chemistry course. We have suggested that the Division of Chemical Education of the American Chemical Society appoint a standing committee whose business it should be to promote investigations of problems of high-school chemistry instruction. We make these suggestions because syllabi committees are very frequently forced to pass judgment upon questions with inadequate evidence.

From time to time the Division of Chemical Education would make recommendations concerning ways and means of improving high-school chemistry instruction, making use not only of committee judgment, but also of the facts which have been brought to light by the various investigations that have been promoted by the committee on research in high-school chemistry instruction.

Microbe Hash to Cure External Tuberculosis.—An electrified mixture of pulverized microbes and iron filings for the cure of exterior tuberculosis, such as lupus, tuberculosis adenitis and the like, was presented to the Paris Academy of Science, June 22, by Professor Charles Richet. The process is the invention of Dr. Arthur Grimberg, and has been tested on over 250 patients already. It consists essentially of a colloidal extract of the Koch bacillus, injected under the skin of the sufferer.

The microbes are the base of the preparation. The iron filings are used in breaking them up. By placing a culture of these bacilli in a tube together with iron filings, and subjecting them to a variable electro-magnetic current, they are broken up into a very fine powder-like condition, and brought into solution in the form of a colloidal mixture which will circulate in the blood vessels of a human being and react on the infected parts.

Dr. Grimberg and his assistants report results as being unusually encouraging. The normal treatment is two subcutaneous injections daily. From the number of patients treated, 54 per cent of complete cures have been registered; 26 per cent of ameliorated cases; and 20 per cent of at least temporary checks of the progress of the disease. The latter group, it is said, all gave up the treatments for one reason or another before any permanent result could have been obtained. The greatest number of cures was effected on the soft-lesion type of malady, such as glandular tuberculosis.

It is interesting to note that many of these patients on whom the tests were made had been operated on one or more times without success, or had made long trips for cures. They all reacted promptly to this treatment, and the average case required only from 15 to 20 injections for a cure.

The treatment is being studied by the leading physicians of Paris, and in fact many of the tests were made in the clinics of the big hospitals. A large number of successful cures were presented to the Société de Chirurgie by some of the leading members, who had made the tests personally in their clinics.—*Science Service.*

WHAT THE CHEMIST DOES FOR THE DRUGGIST

ALFRED S. BURDICK, ABBOTT LABORATORIES, CHICAGO, ILL.

At this time, when we are beginning to awaken to the fact that the chemist has a part in almost every material thing that affects our existence and comfort, it seems a bit elementary to point out the relationship of the chemist and druggist. It is obvious to everyone that there is such a relationship. At the very start, the druggist masters a great deal of chemistry in the process of preparing himself to be a druggist. He knows the chemical vernacular. Next to the chemist himself, he probably has a greater knowledge of chemistry than the member of any other profession and it is quite probable that he really knows more chemistry than many who call themselves chemists. In England, in fact, the druggist is known as a "chemist" and the British public is at a loss to understand the difference between the "druggist chemist" and the "chemist chemist."

Obvious as is this relationship of druggist to chemist, I wonder if the full extent of the service rendered to the druggist by the chemist is sufficiently appreciated. Everyone, of course, is familiar with the fact that the druggist handles more pure chemicals than any other merchant. When it is remembered that the list of these chemicals includes not only a host of such standard products as magnesium sulfate, sodium sulfate, sodium bicarbonate, aspirin, phenol, alum, ether, chloroform, iodides, bromides, etc., but also a large array of the more complex and delicate synthetics like acriflavine, arsphenamine and neoarsphenamine, procaine, orthoform, anesthesin, cinchophen and neocinchophen, barbital, luminal, acetanilid, amidopyrine, chlorazene and acetphenetidin, as well as the large number of definite chemical compounds derived from natural sources such as quinine, morphine, adrenalin, thyroxin, cocaine and the great assortment of alkaloids, one begins to appreciate this relationship. It is impossible for the druggist to begin to make these products himself or even test them to satisfy himself as to their purity. He must depend entirely upon the label of a reliable manufacturing chemist.

Not only does the chemist supply these products in a pure form but the very existence of most of them has been due to years of painstaking research on the part of hundreds of chemists throughout the world. Most of these compounds have been created within the memory of many of the older druggists. Fifty years ago most of the medicines used were in the form of extracts from herbs and roots, often laboriously prepared by the druggist himself. Now, many of the specific active principles upon which the extracts depend for their physiological action have been isolated by the chemist and furnished in pure form, free from extraneous material, so that the dose and action of the product can be accurately controlled.

The plant kingdom was scoured for new products—new active principles —that might have still different physiological actions. Then the chemist

began to synthesize compounds that were not found in nature and which exhibited new actions. In many cases he has succeeded in improving on nature and in creating more perfect principles. One outstanding achievement of the chemist is in the field of local anesthetics. As a result of this work cocaine has now been replaced by superior synthetic products to such an extent that some of the leading physicians of England believe that the time has now arrived when the use of cocaine should be prohibited by law.

Thus, it is seen that behind each chemical which the druggist handles, stands not only the skill and dependability of the chemist manufacturing that product but also the vast amount of chemical research necessary to bring it into existence.

In addition to this vast number of pure chemicals handled by the druggist, there are many other products carried in the modern drug store in which the chemist has played a very important role. There is the great cosmetic industry which has expanded so remarkably during the last few years and contributes in large measure to the druggist's volume of business. This expansion may be traced chiefly to the chemist, who has been responsible for the greatly improved quality of the products now offered on the market. This general improvement in quality has made the use of these products much more tempting to the discriminating customer and has greatly increased the demand for them.

Every day new cosmetic articles are being placed on the market and many of them meet wants that have long existed but for which there have been no satisfactory products. In this connection might be mentioned products which control excessive perspiration and also one which prevents sunburn by the use of a cream containing a synthetic compound that absorbs the ultra-violet rays of sunlight. Both of these products are based on scientific research and have real merit.

The perfume industry has been greatly aided by the work of the chemist. He first perfected the extraction of natural odors from flowers, then analyzed these natural products and learned their chemical constitution, and now he has succeeded in preparing synthetically in the laboratory not only nearly all of the naturally occurring products but also has created many new ones which do not occur in nature. This work has added greatly to the resources available to the perfumer in preparing new blends and made possible the use of products the cost of which would be prohibitive if nature were the only source.

In the field of antiseptics great strides have been taken. Twenty years ago the only antiseptics in general use among the laity were bichloride of mercury, tincture of iodine and carbolic acid. All of these are dangerous in the hands of an inexperienced person. Even though they have been used extensively, the demand for them does not compare to the potential demand for really safe and effective antiseptics. The education of the

laity in the proper use of antiseptics should be one of the chief objectives of preventive medicine, but only recently have *safe* antiseptics been available. Here is a big field for the future expansion of the drug business that is being made possible by the chemist.

Even the type of "patent" or proprietary medicine is being greatly changed. Whereas, in the past, the largest selling proprietaries were concoctions known variously as "bitters," "tonics" or "syrups," the list is now headed by aspirin, a definite chemical compound first used in 1900. The United States is now probably the largest manufacturer as well as the greatest consumer of this product in the world. According to the 1920 Census of Dyes and Coal Tar Chemicals, 1,708,436 pounds of aspirin were produced in 1919. It is probable that the present output is in the neighborhood of two million pounds a year. This is the equivalent of 2,800,000,000 5-grain tablets, and at retail must bring at least $25,000,000.

The photographic supplies, handled by nearly every druggist, were perfected by chemists. Were it not for the celluloid high-speed film and rapid print paper, amateur photography would never have attained the popularity that it has today. The art of preparing celluloid film and coating it with gelatin emulsion was developed by an American chemist. Rapid print paper (velox) is the invention of Dr. Leo Baekeland, past-president of the American Chemical Society.

Dr. Baekeland is even more famous for the development of the synthetic resin, bakelite. Although it is now most familiar in the form of radio panels, it is seen in the drug store shaped into cigarette and cigar holders and pipe stems, and forms the barrels of many fountain pens. The druggist sells other synthetic plastics. Much of the "ivory" ware is made of the pyroxilin plastics, a distinctly chemical creation.

The improved rubber and leather goods as well as leather substitutes now available are products in which the chemist has had a hand. Mention should also be made of the dyes sold by the druggist. Even the quality of tobacco, stationery, glassware, labels, wrapping paper and cartons is under the control of the chemist.

In short, it may be said that almost everything the druggist sells has either been created or improved by the work of the chemist. This is true not only of the chemicals and drugs themselves but also in the great variety of other products handled in the modern drug store. The chemist's work is thus constantly increasing the scope of the druggist's business.

It is therefore to the distinct advantage of the druggist to take a lively interest in the chemist and support his activities whenever possible. Only by such active support may we hope to develop a self-contained chemical industry and become independent of the rest of the world for our supply of drugs and chemicals.

Great advances in this direction have been made in recent years. Twelve

years ago we depended upon foreign countries for almost all of our synthetic medicinals. Now these are practically all made in the United States. The quality of the domestic products is not excelled anywhere in the world. They are being made by Americans under American standards of living and wages and are being sold with a fair margin of profit at prices that in many instances are much lower than the foreign prices prevailing twelve years ago. These same foreign manufacturers are now attempting to regain their old business and force American manufacturers out of business by greatly underbidding the present American prices. If the domestic industry should be destroyed, a return to the old foreign prices is a certainty.

Although the present tariff affords some aid in this fight to free America of foreign domination in the field of synthetic medicinals, greatest reliance must be placed upon the spirit of the American people. If we are to continue to be independent in this field, the American chemical profession must have their loyal support. There is evidence at every hand that this is being given. Many American druggists have been farsighted enough to continue their support of American industry even though tempted by offers of cheap foreign products.

The fight for independence in regard to synthetic medicinals, although a most dramatic one, is only a beginning of the struggle for independence in all fields. We are gradually making progress in other lines. This progress is made possible by diligent research and research must be the basis for all true and lasting progress.

A few instances of our growing independence may be related. At present, camphor is imported exclusively from Japan but now there has recently been erected in this country a plant in which synthetic camphor can be manufactured. This artificial product has all of the chemical properties possessed by the natural product. At one time all peppermint oil was imported. Now much of it is produced in Michigan. We now have synthetic local anesthetics, developed and manufactured here, that make the use of imported cocaine all but obsolete.

These are but a few cases in which progress has resulted from research. Much remains to be done. Eventually we must have an independent rubber supply. Substitutes for morphine and quinine and many other natural products from the tropics should be produced. Many diseases remain to be conquered. Only by continued chemical research can results of this sort be achieved.

The druggist and chemist are thus greatly dependent upon each other. The chemist supplies the druggist with new and improved products that lead to an expansion in his business while, by the druggist's active support of the American chemist, an industry is maintained that will eventually lead to American independence in all matters chemical and pharmaceutical —a condition that is essential to our national welfare.

ANALYTICAL CHEMISTRY AT PRATT INSTITUTE—A COMBINATION COURSE IN QUALITATIVE AND QUANTITATIVE ANALYSIS

CHARLES L. MANTELL AND ALLEN ROGERS, PRATT INSTITUTE, BROOKLYN, N. Y.

In order to better satisfy the particular needs of the individuals being trained in the course of Industrial Chemical Engineering at Pratt Institute, after mature deliberation and consideration, the formal courses of qualitative and quantitative analysis were changed to a combined course of both these subjects under the heading of Analytical Chemistry. This paper is presented as a means of provoking discussion as to the advantages and disadvantages of this type of course, which will be described in some detail.

The problem of Pratt Institute in its intensive two-year course in Industrial Chemical Engineering is a peculiar one. Its first consideration is to accommodate purposeful students whose need for an efficient technical training is well defined and urgent, and especially those whose circumstances render advisable or necessary the utmost economy of time or money. Notable among these is the industrially-employed young man of twenty years and upward, to whom practical experience of perhaps two to six years has disclosed his technical bent and demonstrated the indispensability of systematic technical training if he is to make reasonable progress in position and pay.

Also important is the high-school graduate of well-defined vocational purpose, who, for financial or other reasons, is subject to the necessity of spending as few years as possible in technical training before entering employment. The administration of this technical course is intended to make available for men of these types a highly effective training within the shortest time consistent with thoroughness. To this end specially adapted means are employed, of which the following are of particular moment: broad standards of admission, under which the actual fitness of the individual is the determining consideration, approved industrial experience being accepted in lieu of academic training; the elimination of subjects and details of instruction both technical and general that are not essential to a technical education; a curriculum the content and presentation of which are very directly related to technical employment; methods of instruction which tend strongly to develop the students' practical efficiency and executive ability.

The aim of Pratt Institute should not be misunderstood; it does not attempt to cram into two years what is given in the collegiate type of school in four years or more; it does not produce chemical engineers or research chemists, but directs all its energies toward the training of men to become inspectors, department foremen, technical and engineering assistants, technical salesmen, analysts, assayers and assistant chemists. The

graduates of the Institute become the plant men of the industrial organizations.

It has been felt for some time, in consideration of the returns resulting from the time given to the subject of qualitative analysis, that the formal method of teaching was no longer warranted. It was desired to bridge, entirely if possible, the gap existing in the minds of the students between qualitative and quantitative analysis. It had been found to be more and more essential to incorporate in the course greater utilization of the application of mathematical problems of the industrial type; to lay greater and greater stress on applications of basic principles and their utilization, rather than on cultural technique.

As a result, qualitative analysis is taught entirely from a quantitative viewpoint. In any unknown which the student is given it is necessary for him to determine not only what is present but also how much. It can be seen that this involves starting the experiment with a weighed sample of unknown material. In other words, the student does not start with an indefinite mass or volume of a substance whose constituents are to be determined. Qualitative inaccuracy is thus supplanted by quantitative care. The use of the chemical balance and its application in weighing to a tenth of a milligram had been taught in the course in General Chemistry. The later sections of General Chemistry are devoted to the metals, metallic ions and their analytical reactions. General Chemistry consumes 60 hours of classroom work, 12 quiz hours and 120 laboratory hours. Analytical Chemistry consumes 36 classroom hours and 96 laboratory hours for one period of 12 weeks followed by 24 classroom hours and 108 laboratory hours in a succeeding period of 12 weeks.

The first lectures in analytical chemistry are devoted to a review of the ionic theory, the law of mass action and the concept of solubility product and its applications. Emphasis is laid on the fact that analytical reactions are ionic and follow the laws of chemical equilibrium. Succeeding lectures are then devoted to a consideration of the reactions of the first group of metals in the qualitative scheme—silver, mercury and lead—with their separations one from another. Later lectures are devoted to the reactions of the succeeding groups of metals in the qualitative scheme, their reactions and separations. Interspersed between these lectures on the different groups are others concerning themselves with the quantitative procedures based on these groups and metallic ionic separations—thus interweaving qualitative separations with their quantitative applications.

The laboratory work starts with the qualitative analysis of a solution which is known to contain silver, mercurous mercury and lead, the student proceeding with the experiment according to directions given in the scheme for the analysis of the first group. Individual preliminary experiments are entirely eliminated, being in the opinion of the authors of this paper

inadvisable, as for our particular type of student the time to be spent on them is not warranted. In their place is substituted a connected series of experiments, consisting of the analyses of so-called known solutions of the group as above described. This work involves every one of the preliminary experiments ordinarily given and acquaints the student with the manner and method of precipitation as used in the analytical scheme, the colors and characteristics of the precipitates formed, and the conditions under which they are formed in the connected series of operations involved in the experiments. These laboratory tasks are written up by the student as a report submitted to his instructor, in which he tells what he has done, draws a careful scheme of the ionic separations and gives completed equations for the reactions in which the metallic ions have taken part.

Following this the student receives an unknown sample in the form of a dry powder. Following mimeographed directions, he weighs out a sample and proceeds with its quantitative determination as based on the qualitative scheme which he has previously learned. The unknowns (known, of course, to the instructor) are simple salts or mixtures of salts in various proportions. Take, for example, a first-group unknown (Ag, Hg′, Pb″). His first operation is to weigh out an appropriate sample, say one gram. This is dissolved in distilled water with the aid of a little nitric acid, if necessary, and the metals precipitated as chlorides by hydrochloric acid. The precipitates are then filtered quantitatively. The lead chloride is washed on the filter paper with hot water to dissolve it away from the silver chloride, the filtrate being collected and retained for the lead determination. The residue on the filter paper is then washed with ammonia to dissolve the silver chloride and that filtrate used for the silver determination. Any mercury present remains on the filter paper as the black complex amino compound. The lead filtrate is then analyzed for lead by precipitation by a soluble chromate, the lead chromate filtered on a weighed Gooch crucible, dried, weighed and the percentage of lead calculated. The filtrate containing the silver is neutralized with nitric acid, the precipitated silver chloride filtered through a weighed Gooch crucible, dried in an oven, again weighed and the percentage of silver calculated.

The explanation to the student of the method of calculation involves no difficulties for the instructor. The demonstration to the class of the purely mechanical method of filtration as shown in the use of the Gooch crucible with its attendant suction flask and pump also causes no difficulty.

Problem work is begun in the classroom about the same time that the students make their first determinations in the laboratory. The effect of such factors as excess of precipitant, volume of solution and acidity, is explained on the basis of ionic reactions and solubility product. It can be seen from this description that whenever possible the qualitative scheme is used as a basis for quantitative determinations of the metals involved.

It is, of course, realized that some, or perhaps many, of our quantitative procedures cannot exactly follow the qualitative scheme, but in practically all cases the methods of separation learned in the qualitative scheme and the reactions involved are employed in quantitative separations. The students shortly learn the trick of skipping steps in the scheme when the metals involved are known to be absent, thus shortening the procedure, applying this to entire groups, or subdivisions of groups.

The syllabus of the course is divided into three sections: the lecture or theoretical work, the laboratory or practical work, and the mathematical or problem work, in which particular emphasis is laid on industrial applications.

After the metals are completed the same idea is followed through for the acid radicals. Upon the completion of this phase of the work, acidimetry and alkalimetry are discussed and studied. The work for the rest of the course is of a volumetric nature, the previous work having been almost entirely gravimetric. Oxidimetry then follows. Upon the completion of this, iodimetry is undertaken, completed, and the course closed with work in titrations involving the formation of precipitates. The syllabus for this part of the course in many respects compares with the work given in so-called standard courses in a collegiate type of institution.

In this course, texts are supplemented by mimeographed notes based on excerpts from a number of standard texts on qualitative and quantitative analysis.

As has been before stated, this paper is submitted for the sake of arousing discussion and criticism, especially as it may be possible to apply the same procedure to collegiate courses.

EXPECT TWENTY COLLEGES AT CHEMICAL EXPOSITION

About twenty leading American colleges and universities have filed application for their students of chemistry and chemical engineering to take the one week course of intensive training in practical technique of chemical engineering to be held in conjunction with the Tenth Exposition of Chemical Industries at the Grand Central Palace, New York, during the Week of Sept. 28th to October 3rd. More than three hundred students are expected to enroll before the closing date. All students of recognized colleges, as well as practicing chemical engineers, who desire to brush up on fundamentals, are eligible to take the course which is without cost.

A program of lectures for the course for students is now being made up and will be announced at an early date. Some of the leading authorities on engineering methods, materials and equipment will be among the speakers. Lectures will be held during the morning hours at the Grand Central Palace prior to the official opening of the Exposition each day. Tours among the exhibits for practical demonstrations will also be conducted for the students. Examinations will be held at the close of the course as a number of colleges have designated their intentions of giving their students credit toward their degrees for work done at the Chemical Exposition. Prof. W. T. Read of the Chemistry Department of Yale University, is in charge of the course.

CELESTIAL CHEMISTRY

C. E. VAIL, COLORADO AGRIC. EXPT. STATION, FORT COLLINS, COLORADO

Author's Note.—This article has been compiled from a number of sources, one of the most important being Farrington's excellent treatise on Meteorites. The writings of Abbot, Campbell, Eddington, Lowell, Turner and other astronomers have been freely consulted and quoted.

Meteorites
Distinction between Meteors and Meteorites
Classification of Meteorites
Stone Meteorites
Iron Meteorites
Other Meteoritic Components
Organic Constituents
Gaseous Components
Considerations Based on Meteoritic Composition
Origin of Meteorites
Evolution of the Solar System
Spectroscopic Studies
Inferences Drawn from Spectroscopic Observations
The Sun
Form and Distribution of Elements in Solar Bodies
Types of Stellar Spectra
Tracing Stellar Orbits
Stellar Evolution

Up to about seventy-five years ago, physical astronomy, or astrophysics, which treats of the composition and physical state of the heavenly bodies, had received little consideration. Astronomers had been much more concerned with the motions of the stars than with their composition. When the advances in gravitational astronomy had fixed more and more accurately the comings and goings of the sun, moon and stars, the attention of certain scientists was turned to the problem of learning something of the physical nature of our celestial neighbors.

"Light and meteorites," said Humboldt, more than a hundred years ago, "are the only sources of our knowledge regarding the universe external to our world." This statement is still almost wholly true, so that our approach to the topic of celestial chemistry, or the composition of the heavenly bodies, must be along these paths.

Meteorites

Since meteorites yield us the only material evidence of the composition of extra-terrestrial bodies, they may well be considered first. Meteorites, as defined by Farrington, are solid bodies which come to the earth from space. For many centuries there have been tales about rocks that fell from the sky. These stories were generally discredited by the scientists of the eighteenth century, chiefly because of lack of direct evidence of their truth. Later, especially after meteoritic falls were known in Europe and America, scientists began to revise their ideas about both the rocks that had fallen from the heavens and the legends which men had attached to them. It is scarcely surprising that primitive man regarded meteorites with fear and superstition. They were worshipped as gods, or as gifts from the gods, by various peoples all over the earth.

The chief interest which meteorites have for scientists lies in the study of their character and composition, for they enable us to trace some degree

of relationship between our own planet and the other members of our solar system. Further, in connection with the story of the stars, as written by their light rays on our instruments of precision, the elements and compounds which we find in meteorites give us something of a clue to the cycle of changes which the entire stellar universe is undergoing.

A Distinction between Meteors and Meteorites

There is a distinction to be made between meteors and meteorites. Meteors are familiar to everybody as "shooting stars" and may be seen almost anywhere on any clear night. These bodies are quite small, probably varying in size from a pin-head up to about half an inch in diameter. They are probably of the same general composition as true meteorites, although our information in this respect is quite meager. Meteors enter our atmosphere with a velocity ranging from eight to forty-seven miles per second. They are evidently ignited and oxidized, or at least rendered incandescent by their swift passage through the air, and the fragments gradually fall to the earth as dust. In the strict sense of the term, this dust belongs in the category of meteorites. The term meteorite, however, is usually applied to those fragments of a size sufficiently large to exhibit the usual characteristics of these bodies. Meteorites may weigh many tons and have a volume of many cubic feet.

"Meteoric showers" occur with more or less regularity. One of the principal showers comes on August 10th and another on November 13th of each year. The number of meteors entering our atmosphere daily is estimated to be several million. This number is greatly increased at the time of a meteoric shower. These bodies move in true orbits about the sun, as do the meteorites proper. It is interesting to note that the August swarm of meteors moves in the orbit of the comet of 1862. The November shower has been observed over quite a period of years, the most notable showers occurring every thirty-three years. This swarm is likewise considered to be the remains of a comet. As to the origin of comets, we can, at present, only leave the subject open to conjecture.

Considering now meteorites proper, out of over 350 known falls recorded since the year 1800, only one has occurred in conjunction with one of the periodic meteoric showers. On this evidence, it is hardly safe to assign the same origin to meteorites as to meteors; that is, meteorites are not considered to be essential parts of the swarms of small bodies which yield the visible meteoric showers. Many of the recorded falls of meteorites, 100 out of 350, have occurred during May and June. The time of day when the most falls have been recorded is from three to four o'clock in the afternoon. It is estimated that, on the average, about 100 tons of meteoritic matter reaches the earth daily, most of it as dust, but occasionally in the form of the larger masses termed meteorites.

The Classification of Meteorites

Turning now to the composition and characteristics of meteorites, we may treat of the following divisions of the subject: classification, structure, elements, compounds, terrestrial relations, and probable origin.

The chief classes of meteorites are: (1) Stones, which are mostly silicates, and (2) Irons, which are mostly metals. These two principal classes are subdivided into 76 minor classes, based on composition.

Most of the meteorites known are of a stony nature. They may grade, however, from much stone and little metal up to all metal. The second chief class, as the name indicates, is composed almost exclusively of iron, alloyed with 5 to 25% of nickel.

TABLE I—AVERAGE COMPOSITION OF METEORITES

Element	%
Iron	72.07
Oxygen	10.10
Nickel	6.51
Silicon	5.20
Magnesium	3.80
Sulfur	0.49
Calcium	.46
Cobalt	.44
Aluminum	.39
Sodium	.17
Phosphorus	.14
Chromium	.09
Potassium	.04
Carbon	.04
Manganese	.03
Other elements*	.03
	100.00

* Argon, Chlorine, Copper, Hydrogen, Helium, Iridium, Lithium, Nitrogen, Palladium, Platinum, Radium, Ruthenium, Tin, Titanium, Vanadium.

Meteorites generally possess a crust, formed by frictional heat on passing through the air. This fusion of the surface may often be accompanied by pitting, scoring, or other deformation of the mass before it reaches the solid earth.

Meteorites often contain so-called "veins" but these are not analogous, except in appearance, to veins in terrestrial rocks. The veins of a meteorite have the same composition as the main mass, and are probably in most cases of the same origin as the crust.

Stone Meteorites

The stone meteorites very often show a granular structure, the grains or spherules being called *chondri*, and the structure referred to as *chondritic*.

Chondri may vary in size from microscopic dust-like particles up to bodies the size of a walnut. Most of them are about the size of millet seed.

Iron Meteorites

In meteoritic irons a definite crystalline structure is usually found, which is best brought out by etching the polished flat surface of a section of the meteorite with acid. The etched figures thus produced are usually called the *Widmanstätten* lines or figures, after the investigator who first described them to any extent. The irons which yield octahedral figures are called *octahedrites*. Another class of irons is found to possess a different crystalline structure, showing, when etched, what are known as the *Neumann lines*. These irons are referred to as *hexahedrites*. A third class of irons, which seem to yield no etching figures, and which, except for accessory minerals, are quite structureless, are called *ataxites*. The etching figures are generally considered to be sufficient proof that a specimen of iron is of meteoritic origin, since terrestrially occurring iron does not show these figures.

The elements that have been found in meteorites are indicated in Table I.

Other Meteoritic Components

Such a mixture as this would have a density very near that of the earth, which is 5.57. The average specific gravity of all known meteorites is 3.65.

TABLE II—COMPOSITION AND DENSITY OF TWO METEORITIC IRONS

No. 1	Iron 83.85%	Nickel 15.03%	Sp. Gr. 7.566
No. 2	Iron 80.65%	Nickel 18.20%	Sp. Gr. 7.561

Elements of somewhat doubtful occurrence in meteorites, that is, those which seem to be present only in minute traces, are arsenic, antimony, gold, lead, tungsten, uranium and zinc. It is a noteworthy fact that barium and strontium have not yet certainly been identified in meteorites. It has been stated by some authorities that radium has so far been determined in only one meteorite, but that the stony meteorites have, on the whole, about one-fourth the radioactivity of granite. Up to the present time, no new elements have been found in meteorites.

TABLE III—AVERAGE COMPOSITION OF 53 STONY METEORITES

	%		%		%
C	0.15	FeO	14.58	Cu	0.02
SiO_2	38.68	Ni	1.15	CaO	2.42
S	1.80	NiO	0.48	MgO	22.67
P_2O_5	0.26	Co	.07	Li_2O	trace
Cl	.08	CoO	.06	Na_2O	0.87
TiO_2	.18	Cr_2O_3	.47	K_2O	.21
Al_2O_3	2.88	MnO	.29	H_2O	.75
Fe	11.98	V_2O_3	trace		
				Total	100.05

Table II shows the composition and density of two typical iron meteorites.

It may be mentioned here that there are no iron meteorites known that do not contain nickel. Many of them also contain cobalt and copper.

Table III gives the average composition of 53 stony meteorites.

It will be observed that the oxides of silicon, iron and magnesium, with some metallic iron, make up the bulk of this class.

Carbon has been found in the form of diamond and graphite, chiefly in the irons.

The compounds which are most usually found in meteorites are silicates, corresponding in a considerable degree to a number of terrestrial minerals. There are also present sulfides, phosphides, carbides and oxides.

Chondri, which are so commonly found in meteorites, are composed largely of silicate minerals, while carrying a little nickel-iron.

True glass, generally of a brown color, is a common constituent of meteorites, indicating that the compounds composing this glass had solidified too quickly to allow them to take on a crystalline structure. This glass, like the crust, is probably the result of atmospheric fusion.

Organic Constituents

There is a sub-class of meteorites which contains carbon in the form of compounds with hydrogen, with hydrogen and oxygen, and with hydrogen and sulfur. The hydrocarbons extracted from carbonaceous meteorites, using suitable solvents, usually have a bituminous odor and are combustible. In fact, some of these substances resemble ozokerite, or mineral wax, and are referred to as "meteoritic petroleum" by some investigators.

Extraction has also yielded substances resembling peat, humus or lignite in composition and properties. These substances are chiefly composed of carbon, hydrogen and oxygen. Such extractives generally make up less than one per cent of the masses in which they occur. They are probably of inorganic origin as there is as yet no good evidence that they have originated through life processes. In this connection we may recall the suggested origin of terrestrial hydrocarbons, such as are found in petroleum, from the interaction of carbides with water or acids. While reactions of this type take place on the earth only with artificial carbides, they may well have occurred in the bodies from which the carbonaceous meteorites have been derived, since some meteorites have been shown to contain carbides of iron, nickel and cobalt. Further, the hydrocarbons derived from carbides are often unsaturated, and the presence of nickel and vanadium in various petroleums and natural asphalts suggests that these metals may have acted as catalysts in the natural hydrogenation of unsaturated hydrocarbons.

The presence of carbonaceous substances in meteorites indicates that

the bodies in which they occur could not have been subjected to very high temperatures subsequent to the formation of these substances, at least in the presence of oxygen or oxidizing agents. The most logical explanation of their occurrence is that they have been developed in the mass of the meteorite by contact with water after reaching the earth.

In the ether extract from certain meteorites have been found compounds of the general formula $C_4H_{12}S_5$. Similar products have been obtained from cast iron, and also by the action of ether on sulfur or iron sulfide in the presence of oxygen. It may be questioned whether in making such extracts the carbon and hydrogen were derived from the meteorite or from the ether used as the solvent. On the other hand, daubreelite, $FeS.Cr_2S_3$, may be prepared artificially by treating an alloy of iron and chromium at red heat with hydrogen sulfide. This suggests the possible origin of this mineral, as well as the compounds of the formula $C_4H_{12}S_5$.

Gaseous Components

All meteorites evolve gas on heating. These occluded gases consist in general of hydrogen, helium, argon, nitrogen, carbon monoxide, carbon dioxide and methane. The amount of gas so obtained is quite variable. Table IV gives the volume limits of gases found in a number of stones and irons.

TABLE IV—GASES IN METEORITES

	Stones, vols.	Irons, vols.
Hydrogen	13.0–58.0	14.0–85.0
Nitrogen	0.0– 4.9	1.7–17.7
Carbon monoxide	1.3–39.0	4.5–71.0
Carbon dioxide	28.0–93.0	0.1–14.0
Methane	0.0– 7.7	0.0– 4.5
Helium and argon	traces	

It is to be noted that carbon dioxide is most abundant in the stones, while hydrogen and carbon monoxide are most abundant in the irons. The origin of these oxides of carbon constitutes an attractive problem.

All of the gases discussed above are considered to be occluded in the meteorites, much as platinum and palladium occlude hydrogen, rather than being wholly contained in pores or cavities.

Considerations Based on Meteoritic Composition

The study of the composition of meteorites leads at least to some interesting considerations, if not to any definite conclusions. From the standpoint of chemical composition, the chief contrasts between meteorites and terrestrial rocks may be stated thus: the rocks of the earth's crust are composed largely of silica (both free and combined), lime, alumina and the alkalies; meteorites abound in iron, nickel and magnesia.

Goldschmidt's theory of the composition of the earth[1] is this: a shell or zone of rocks, chiefly silicates, with a density of 2.8, extends to about 70 miles below the surface; next is a shell of compressed silicates, density 3.6–4.0, extending to about 725 miles below the surface; next is a zone composed of the sulfides of iron, chromium and titanium, with metallic copper, silver, gold, etc., extending to about 1750 miles deep; next is the actual nucleus of the earth, probably composed of nickel-iron, containing 6 to 10% nickel, with a density of 8.0.[2] It is known that the whole earth has a specific gravity of more than twice the density of the crust. This fact, together with the fact that the earth acts as a great magnet, and has nearly the rigidity of steel, suggests that a large part of the bulk of the earth must consist of iron. This further suggests the analogous structure of the contents of a blast furnace, charged with sulfides, with the iron at the bottom, the matte above the iron, and the siliceous slag at the top.

In some cases meteorites exhibit structures very similar to certain terrestrial volcanic rocks, such as basalt, dolerite, and volcanic breccia or tuff. If the earth's nucleus and lithosphere originally were similar in structure to those of typical meteorites, the subsequent changes wrought by mineralizing agents, weathering agents, and the like, together with vulcanism, might account for the general schematic arrangement of the several spheres as we know them. Or if the materials of meteorites were allowed to undergo all these changes, they would resemble more and more the rocks of the earth's crust.

Origin of Meteorites

The modern hypothesis of the origin of meteorites considers them to be parts of a shattered star, planet or planetoid. All the evidence seems to point to the conclusion that they are fragments of some larger pre-existing body or bodies. As to how a celestial body could be shattered there are two chief suppositions: first, that the shattering was caused by direct collision; or, second, which is the more probable, that a much larger body, of great density, moving with great speed, produced torsion and tidal stresses of sufficient magnitude in the smaller body to cause disruption. We have some evidence of this if it is true that certain meteoric swarms are fragments of comets.

The Evolution of the Solar System

At this point it may be well to touch upon the theoretical evolution of our solar system. As conceived by the majority of modern astrophysicists, it is essentially as follows:

The first phase may have been brought about by a large star, A, passing

[1] Goldschmidt, *Z. Elecktrochem.*, **28**, 411 (1922).

[2] Williamson and Adams, of the Carnegie Institution of Washington, suggest a somewhat similar structure.

close enough to a smaller solid or semi-solid body, *B*, to effect the disruption and disintegration of *B*. *A* may have lost a considerable part of its volume, especially the lighter gases. Velocities imparted to the fragments of *B* caused them to collide and develop heat so that a large part of the original mass of *B* became gaseous. In the following nebular phase the largest fragments constituted nuclei about which the materials of the sun and planets eventually collected. The organized phase of our system then followed, in which the solid and gaseous matter of the nebula became segregated into more definite groupings. The planets acquired their principal bulk of matter, together with their respective groups of satellites. The lesser planets, or asteroids, acquired orbits of sufficient magnitude to prevent their coalescing much further. The remaining fragments, meteors and meteorites, having quickly lost their initial heat, moved in swarms of more or less magnitude, likewise without coalescing, and probably with orbits at very high angles with the plane of the planetary orbits. Other masses, with orbits of very great eccentricity, became comets. The present stage of the system is very near to stability, as regards further adjustments of masses of matter in relation to the sun and to one another.

Light a Source of Celestial Knowledge

We noted that our second source of knowledge concerning the composition of the heavenly bodies is light. While we are able to glean very little information along this line by direct vision of either self-luminous bodies or those which only reflect light, the applications of physics in the interpretation of chemical phenomena have given us a fairly extended and accurate knowledge of the subject.

Direct vision affords evidence which is largely inferential. Unaided by instrumental evidence we make deductions solely through analogy. Thus, we can observe the polar caps of Mars, which, with their seasonal changes, suggest the presence of water on that planet. Lowell claims to have visual evidence of sandy areas on Mars, inferring that they are essentially deserts. But such evidence needs instrumental confirmation before we are able to make definite assertions concerning the composition of another planet's surface.

We may well discuss at this point a theory as to the character of the moon's surface. As is well known, at the time of new moon the major part of the moon's disc is in shadow, but the outline of the disc is quite visible. This is often called "earth-shine" and is considered to be due to the reflection of light from the earth's surface to the moon. Numerous objections are offered to this explanation, and it has been suggested that this "earth-shine," which is somewhat variable, is due to the presence of rock masses on the moon, rendered phosphorescent by the prolonged exposure to intense sunlight during the moon's day period. We know that

insolation may produce phosphorescence in certain of our earth minerals such as the phosphates, carbonates and fluorides, especially of the alkaline-earth metals. Radioactive minerals are also known to assist in producing phosphorescence of this kind. Headden's recent work in this field on calcites[3] suggests the possibility of analogous phenomena taking place on the moon.

Photography with ultra-violet light reveals the fact that certain substances, such as zinc oxide and sulfur, which photograph white with ordinary light, show black with the ultra-violet rays. Certain areas on the moon which photograph in this way give us an idea of something of the possible constitution of the moon's surface. Direct evidence is, however, wanting in this respect for the moon and the planets.

Spectroscopic Studies

The instrument which has yielded the most information in regard to the physical character of the stellar universe is the spectroscope. Combined with the telescope and camera in the form of the modern spectrograph, the spectroscope reveals a remarkable amount of detail concerning both the composition and the motions of the stars.

The spectroscope was applied to the study of sunlight and starlight by Fraunhofer over one hundred years ago. He showed that the continuous spectrum given by white light was different from the spectrum of sunlight in that the latter was seen to be crossed by a great number of dark lines. These have since been referred to as the Fraunhofer lines. The laws of spectrum analysis were established some years later by Kirschhoff, and it is upon these laws that we depend for our knowledge of the constitution of the sun and stars.

Kirschhoff's laws are stated thus:

1. An incandescent solid, or liquid, or even gas under high pressure, gives a continuous spectrum.

2. A glowing gas, unless maintained under high pressure, gives a discontinuous spectrum made up of bright lines or bands.

3. A gas absorbs from white light passing through it those rays which the gas itself emits when it is incandescent.

This last law refers to absorption spectra, with which we are now most concerned.

Inferences Drawn from Spectroscopic Observations

Since all elements, and probably all compounds, emit characteristic sets of light waves of different but specific lengths, when such light waves are produced and observed under comparable conditions, we have a very delicate and definite means of detecting the presence of individual sub-

[3] Headden, *Am. J. Sci.*, **5**, 314; **6**, 247.

stances whether pure or in mixtures. Applying these principles to sunlight and starlight, we are able to determine the constitution of the bodies which emit the light. Even the light of meteors, although difficult to observe, has been known to show the presence of sodium and magnesium.

In the case of the planets, the spectra of Venus, Mars and Jupiter seem to show the presence of water vapor in their atmospheres. Jupiter also exhibits the characteristics of an atmosphere containing heavy hot vapors which are little, if at all, self-luminous. The inference is that Jupiter and also Saturn are either molten or red-hot. The spectrum of Uranus shows lines which are not as yet identifiable. These lines are faintly exhibited by Jupiter and Saturn, quite strongly by Uranus and Neptune. Uranus seems to have an enormous extent of atmosphere, while Neptune, which shows both hydrogen and helium, appears to be almost wholly gaseous.

It has been reported that the heads of comets show the spectra of carbon monoxide, cyanogen and sodium. We may here trace some resemblance in constitution to meteors and meteorites.

The Sun

The last and greatest member of our solar system to be considered is the sun. While in classification it is placed among stars of similar character, it is, because of its comparative nearness, by far the best known of all bodies of its class.

The first steps toward the determination of the composition of the sun were taken by Kirschhoff and Bunsen, who showed that the dark lines in the solar spectrum, the Fraunhofer lines, coincided with the bright lines given by various terrestrial elements. Their pioneer work has been so greatly amplified and their conclusions so uniformly upheld that scientists apparently cannot disprove the validity of the methods of chemical analysis which they developed.

We will now notice the chief divisions of the sun's mass. The term photosphere refers to the sun's brilliant surface. The chromosphere is that portion of the sun's atmosphere which lies above the photosphere. By the use of appropriate instruments, certain prominences or protuberances may be commonly seen leading upward from the chromosphere. These prominences are of two classes, the cloud-like and the eruptive. The former has the same composition as the chromosphere, while the latter contains material from the photosphere as well, since such material is carried up suddenly and with very high velocity. The lower portion of the chromosphere is usually referred to as the "reversing layer." The corona is the envelope of light which lies outside the chromosphere, and is observable only at the time of a solar eclipse. It seems to change its form and appearance from time to time.

Sun-spots are the dark areas which develop on the surface of the sun

and appear to be depressions in the photosphere. The physics of sun-spots is highly complex. They are centers of violent disturbances which are doubtless partly electrical in nature. The appearance of these spots is often coincidental with pronounced electrical disturbances on the earth. These effects include storms, auroral displays, and serious interference with electrical signals. The relation of the sun to our weather is a subject which has aroused a great deal of discussion and observation. While authorities declare that no such relation exists, instrumentally demonstrable, yet it is agreed that there is a relation between sun-spot activity and terrestrial and atmospheric electrical phenomena. Any real effect on the weather is thought to be purely local, if it exists. If the hypothesis is correct that electrons, shot forth from the sun, are responsible for the effects just referred to, we have a possible source of information, other than light, concerning the sun's physical state.

Faculae are the reverse of sun-spots, appearing as an irregular net-work of areas which are brighter than the major portions of the photosphere.

Table V shows the elements which have thus far been identified in the sun by means of the spectroscope.

TABLE V—ELEMENTS IN THE SUN

Aluminum	Molybdenum	
Barium	Neodymium	
Beryllium	Nickel	(presence doubtful)
Cadmium	Palladium	
Calcium	Potassium	Gallium
Carbon	Rhodium	Iridium
Cerium	Rubidium	Lithium
Chromium	Scandium	Nitrogen
Cobalt	Silicon	Osmium
Columbium	Silver	Oxygen
Copper	Sodium	Platinum
Erbium	Strontium	Ruthenium
Germanium	Sulfur	Terbium
Helium	Tantalum	Thorium
Hydrogen	Tin	Tungsten
Iron	Titanium	Uranium
Lanthanum	Vanadium	
Lead	Yttrium	
Magnesium	Zinc	
Manganese	Zirconium	

Some authorities assert that no compounds exist in the sun. Others claim to have found spectroscopic evidence that certain compounds may exist there; for example, that in certain sun-spots the presence of the hydrides of magnesium and calcium, together with titanium dioxide, was indicated. In making deductions of this character there must be taken into consideration the various physical states of substances which may

quite appreciably affect their spectra. The Zeeman effect, for example, which results from the action of a magnetic field upon light, has been found on making a careful study of certain sun-spot spectra. This effect widens, doubles or triplicates spectral lines. Likewise, pressure effects and dispersion effects may have an important bearing on the interpretation of stellar spectra. We cannot base definite conclusions concerning such phenomena on other than laboratory experiments, in which these effects as far as possible are duplicated, the resultant spectra being mapped and tabulated.

Form and Distribution of Elements in Solar Bodies

The elements in the solar atmosphere seem to exist in a more or less definite arrangement, probably due to differences in pressure and temperature. Next to the photosphere, in the reversing layer, we find heavy metals such as iron, manganese, cobalt, nickel, copper, etc. In the lower layers of the chromosphere occur both ionized and neutral atoms of the common metals. The ionization potentials of various elements with their accompanying spectra have been determined in the laboratory, and a comparison of these with spectra of various portions of the solar atmosphere has been made. We may thus determine something of the atomic state of these elements in the sun. The ionization potential of an element is defined as the amount of energy, stated in volts, required to remove an electron from an atom. The higher the ionization potential of an element, the more difficult it is to ionize that element by heat. While hydrogen is completely dissociated into atoms throughout the solar atmosphere, that is, it does not exist as molecules, it, as well as helium, is thought to be unappreciably ionized anywhere in the sun.

In the higher portions of the chromosphere we find calcium, strontium, and barium almost completely ionized, due to the lower pressure. In this region we also find ionized iron atoms together with those of scandium and titanium. Since sodium is sixty per cent ionized in the photosphere, it follows that it is more completely ionized in the chromosphere, together with potassium and rubidium. Incandescent hydrogen seems to be the most abundant element in the chromosphere. The corona appears to contain sub-incandescent hydrogen, along with helium, and probably an element called coronium, not yet found on earth.

The question may be asked, what, in reality, are the substances in the sun that give the white light? Since the solar spectrum is continuous and is crossed by dark lines, it follows that the substances yielding the white light are solid, liquid or highly compressed gases. The dark lines are caused by absorption in the reversing layer of the chromosphere, showing that this layer is gaseous. Since this region is cooler than the photosphere, we necessarily conclude that the photosphere is made up chiefly of

incandescent vapors under sufficient pressure to cause emanation of a continuous spectrum. The depth of the photosphere appears to be entirely unknown, as well as the character of the main bulk of the sun's mass. Such elements as carbon, silicon, platinum, tungsten, etc., which are so difficult to volatilize on the earth, may account to some extent for the incandescence of the photosphere.

Types of Stellar Spectra

One hundred years ago, Fraunhofer found that there are different types of stellar spectra. We may now notice in Table VI Secchi's classification which gives a general idea of the chief groups of stars, as regards their spectral types.

Table VI—Secchi's Star Types

I	White stars
II	Yellow stars
III	Orange or reddish stars
IV	Very red stars

Type I, the white stars, gives spectra rich in blue and violet light, with strong absorption lines of hydrogen and helium. About half of the bright stars belong to this type. Type II, the yellow stars, includes our sun. The metallic lines are numerous and prominent, with the hydrogen lines subordinate. This type includes nearly all the stars not included in Type I. Type III, the orange or reddish stars, gives metallic lines stronger than in Type II, with inconspicuous hydrogen lines. Type IV, the very red stars, shows almost wholly metallic spectra. The above constitutes Secchi's classification in its briefest form. To these types, Pickering added a fifth, including the stars and nebulae which give bright-line instead of absorption spectra. While this classification is suitable for the layman, for the specialist it is now superseded by the much more complete and complex system proposed by the Harvard Observatory. There are, naturally, a great many stars with spectra intermediate between Secchi's principal types, and the Harvard classification was designed to take care of these, thus giving a continuous series.

The stars of Secchi's Type I evidently have the highest temperatures of the four types. Their spectra indicate that the main bulk of the mass is enveloped by gases, principally hydrogen and helium. At the other extreme, that is, in the very red stars, with lower temperatures, it is probable that compounds exist.

Besides hydrogen and helium, other elements that are thought to be present in stars are sodium, potassium, calcium, magnesium, iron, antimony, bismuth, tellurium, mercury, radium, radon and uranium. Contributions are continually being made to our knowledge of the stars, in regard to their composition.

In the study of variable stars, that is, stars whose brightness undergoes a periodic change, those of red color show that the bright hydrogen lines are intense near the times of maximum brightness. This may be due to an outburst of hydrogen at such times. It is possible that in very red stars there is a struggle to form a crust over the surface. If such a temporary crust is formed, the light must diminish; when the vapors enclosed beneath the crust attain a critical temperature and pressure, they burst through the crust, which is then re-melted or partially vaporized, and the incandescent vapors of the lighter elements, especially hydrogen, are projected outward from the star's surface with great speed. Such a point may eventually be reached in the case of our sun.

Tracing the Orbits of Stars

The spectroscope has done a very great service to astronomy in a number of ways. One notable aid has been in the application of the Doppler-Fizeau principle. This, in brief, is the effect of recession or approach of a star on the spectrum which that star produces. On comparing the elemental spectra in the light of a given star with a standard set of spectra, it is usually found that the two sets of lines do not coincide. There may be a shifting of the lines toward the violet end of the spectrum, which means that the body is approaching the observer. If the lines are shifted toward the red, the body is receding. Among other things, this effect has enabled astronomers to calculate the velocity with which the stars are moving, and also to determine their direction, relative to each other. To do this, the radial motion of a star is determined, after which its true velocity and direction are calculated, the proper motion of the star and the velocity of the observer being known. The radial motion is one of the components of the star's true motion, and is its motion in the line of sight, as determined by the spectrograph. Thus, the phenomena of "star drift" have been developed, showing how great groups of stars may have a common direction of motion, and, what is still more suggestive, a common spectrum.

The spectrograph has also aided in the discovery of binary stars. Spectroscopic binaries consist of a bright star which alternately recedes and approaches, postulating the presence of an unseen or dark companion body, both bodies rotating about the center of mass of the system. About half of the helium stars, so far as they have been observed, are spectroscopic binaries.

In recent years another instrument of great utility to the astronomer, the interferometer, has shown how one may determine the diameter of a star. This instrument, with the spectrograph, enables us to learn much about a star's size, distance, luminosity, motion and composition. The diameter of a star, with its spectrum, gives us a clue to its age or evolutionary phase.

Stellar Evolution

Our present knowledge concerning the physical state of the stars leads us to a consideration of stellar evolution. But before taking up such hypotheses, let us look at the constitution of nebulae for a moment. The spectra of nebulae show the presence of hydrogen, helium and sodium. About half of the nebulae give bright-line spectra instead of absorption spectra, showing that they are composed of material in the proper physical state to emit such light. Lowell divides nebulae into two classes, amorphous and structural. The spectra of amorphous nebulae show a few bright lines, due chiefly to hydrogen and helium together with "nebulium," which is not known on earth.

The structural or spiral nebulae yield a continuous spectrum and are referred to as white. "Continuity of spectrum postulates discontinuity of mass," says Lowell. These continuous spectra show faint dark lines crossing them, with the faint bright lines of hydrogen and helium. "White nebulae, then, have a continuous background of light due to heated solid meteorites, with bright lines of glowing gases, the dark lines being due to other gases which are not incandescent, lying in our line of sight."

As already noticed we may infer that nebulae eventually condense and coalesce to form stars. A certain residue may remain in the form of planets, satellites, meteorites, etc. This residue, compared with the total mass of the nebula, may be quite small. It is estimated that the total mass of the matter in our solar system, outside of the sun, is equal to less than 0.2% of the mass of the sun.

The stars do not differ much in ultimate chemical composition. Earth, meteorites, sun and stars possess many substances in common. Those elements which are truly universal in distribution may serve to indicate something about the origin of all the celestial bodies.

Whatever their origin, the "life history" of the stars seems to be indicated by the following facts: It has been found that stars of Type III are divisible, based upon their luminosity, into two distinct groups. These groups are the very bright stars, called giants, and the very faint ones, called dwarfs. There seem to be none of intermediate size. The same is true in minor degree for stars of other types, but as we approach the Type I stars there is not so much of an interval as in the first class. That is, there are discoverable gradations in luminosity. From this, the evolution of a star has been developed in theory as follows: the temperature of a star first rises, and then falls; there is a progression in spectral type, accompanied by a change in the volume of the star's mass. A star's diameter is, of course, the surest index of its volume.

Stars having the greatest mass attain the highest temperatures, giving spectra of Type I, highest limits. A star of intermediate mass, like our sun, attains its highest temperature with the development of spectra of

Type I, lowest limits. Our sun is now a dwarf star, of spectral Type II, with a surface temperature of about 6000°C., and an absolute magnitude of 5.1. There was a time when the sun's spectral type was the same as at present, but its absolute magnitude was near zero, which means that it was giving off 100 times the light it gives at present, and its surface was 100 times more extensive. The diameter of the sun was then ten times the present diameter, which is about 866,000 miles. It was certainly classifiable as a giant sun.

The hypothesis of stellar evolution, as worked out mathematically, states that "giant stars are made up of gases so diffuse that they obey the gas laws perfectly. With contraction the temperature rises to a maximum which is dependent on the mass, then follows a gradual lowering of temperature due to loss of radiant energy, and the stars become dwarfs. About half the energy of giant stars is present as radiant energy, which exerts a pressure opposing gravity. All giant stars have nearly the same opacity, so that they all have about the same luminosity."

But something is required to supplement the contraction hypothesis in order to account for the facts. The source of the enormous amount of energy displayed by any one star, even our sun, not to take into account the millions of other suns which we can see, has always been a great mystery. We may be on the right road to a solution when we attempt to explain it by sub-atomic energy. This hypothesis is certainly an alluring one, and already we have record of considerable work done in this direction. It is stated that "if 5% of a star's mass consists initially of hydrogen atoms, which are gradually being combined to form more complex elements, the total heat liberated will more than suffice for our demands and we need look no further for the source of a star's energy."

Ever since the discovery of radium we have been observing how certain elements decompose into other elements. We have so far been unable to reverse the process, and build up the more complex elements from the simpler. In fact, this synthesis has not yet been certainly observed. If we are ever able to completely solve the riddle of the stars, we may be able to utilize sub-atomic energy, which, some one has said, "will prove to be either the destruction or the salvation of the human race." As it is, we are constantly learning new things, finding new fields to be entered and explored, and widening the scope of human understanding. In time we may come to realize our true place in the universe, to learn our real destiny, and to know the full beauty, unity and wonder of all creation.

PREDICTING PERFORMANCE IN CHEMISTRY

JACOB CORNOG AND GEORGE D. STODDARD, UNIVERSITY OF IOWA, IOWA CITY, IOWA

The Necessity for Placement Tests
The Nature of Tests Employed
The Philosophy and Content of These Tests—The Aptitude Test
The Training Test
Data and Conclusions Obtained
Value and Uses of These Tests

The Necessity for Placement Tests

The old problem of square pegs and round holes is fully appreciated by teachers and administrative officers who each fall are confronted with the task of rendering effective the instruction in freshmen chemistry. Year by year young folks come in increasingly large numbers, from all sorts of homes, and with high-school training widely varying both in content and thoroughness. With increasing numbers the perennial problems of choice of subject matter, formation of sections, making instruction effective, what to do with the superior and laggard students and many other related problems become more acute. In common with teachers everywhere confronted with these problems, we have for many years tried various expedients that gave promise of better results.

The Nature of Tests Employed

Among them the general intelligence test was and is of considerable help in getting the measure of a large group of students, but the accuracy with which the general intelligence test predicts individual attainment in freshman chemistry compels the question, "Does ability to do well in chemistry require general or particular ability?" Stated differently, students who make highest grades in chemistry or any other subject for that matter, generally make high scores in a general intelligence test, but from experience we know that many students who make high scores in the general intelligence test do poorly in chemistry. This paper is the preliminary report of tests devised with the object of getting better prediction of student performance in freshman chemistry than is ordinarily secured by general intelligence tests. We have composed two tests: a chemistry aptitude examination for freshmen who have not had high-school chemistry and a chemistry training examination for students who offer entrance credit in high-school chemistry. Each of these tests may be given in one class hour, preferably the hour of the first class meeting at the beginning of the year.

The aptitude examination is based on the assumptions (*a*) that there are personal characteristics generally possessed by students who do well in chemistry and lacking in those who do poorly or fail, (*b*) that these characteristics can be measured more or less accurately by suitable tests, and (*c*) that final semester grades are a fair standard in judging the accuracy of prediction. The chemistry training test for students who have had

high-school chemistry is based on the assumption that the extent and accuracy of the knowledge of high-school chemistry a student possesses at the time he begins his college work in chemistry, as measured by his score made in the training test, is a fair indication of what he will do in the college course, provided his knowledge is sufficient to warrant trying to use the knowledge gained from the course in high-school chemistry as the basis for more advanced work in college. Admittedly all these assumptions are fallible. As pointed out by one of us in a previous publication[1] the final grade received by a student in any course is the summation of a large number of factors, some of them quite beyond the individuality of the student. In this summation of factors determining the final semester grade, general or special intelligence are only single factors. Such things as laziness, financial troubles, ill health, outside interests, and the like will always be factors whose influences cannot be measured by any test. Some letter systems of assigning final grades in which half the class receive the same letter grade is another inherent obstacle in the way of securing close agreement between prediction based on tests and confirmation of this prediction based on final semester grades. But, taking things as we find them, we believe we have devised two tests whose predictive value will be sufficient to make them of considerable help to teachers and administrative officers in the organization and administration of instruction in courses in beginning chemistry. The future tense is used intentionally. The tests were composed in 1924 and tried during the school year of 1924–25 by the institutions mentioned in the table on page 704 with the results there indicated. In the light of these results the tests have been modified. Some test material that was found to be too difficult or without predictive value has been eliminated. Some parts have been extended. But the tests are substantially the same as when originally composed. Copies of these tests may be obtained by teachers or institutions from University of Iowa Extension Division at $2^1/_2$ cents each, which is the cost price of production. We hope that many institutions will try them in their classes this fall, and report to us results obtained so that the merits and defects of these tests may be known with certainty.

The remainder of this paper attempts an exposition of the following items.

1. The philosophy and content of these tests.
2. Data and conclusions obtained from use of these tests.
3. Value and uses of data from these tests.

The Philosophy and Content of These Tests—The Aptitude Test

In the attempt to devise a technique for predicting the future degree of success of individual students taking a first course in chemistry, we guessed

[1] Cornog and Bartow, *Ind. Eng. Chem.*, **15**, 301 (1923).

a relation would probably exist between the four following qualities and the final marks a student would make.

1. The ability to apply arithmetic to the solution of simple problems associated with physical phenomena, also the interpretation and use of simple mathematical formulas. Possibly the ability to think quantitatively is related to chemical success. The test measures this ability by a series of 20 arithmetical problems.

2. Ability to form accurate mental images from the reading of simple, elementary chemistry texts. The habit of getting sharp, well-defined images from reading, rather than hazy ones may be a factor of success. The test measures this capacity by 30 true false questions based on elementary chemistry text material printed in the examination.

3. Ability to follow a sustained, technical, abstract, possibly abstruse line of exposition, and at the conclusion to be able to recall the salient features of the argument. This is measured by a reading test based on a rather long and difficult paragraph of theoretical exposition.

4. An inborn interest in natural phenomena. The attempt to measure this is based on the answering of a list of sixty true false questions involving general information concerning natural phenomena, such as water, electricity, electric lights, radio, color of the sky, etc. The supposition is that a person interested in such things would be interested in chemical phenomena and that an interested student is more apt to do well than one who is not interested.

These four may be summarized in the statement that students who can think abstract ideas accurately and who have a taste for the mechanics of natural phenomena are apt to do well in chemistry.

The Training Test

There were two bases for the selection of matter in this test: first, a knowledge of chemical phenomena selected from as many and as wide fields as the space limitations of the test allowed; and second, the experience of one of us extending over a period of years in personally interviewing freshman students who had failed or seemed about to fail in chemistry. The object of these interviews was to learn the reasons for failure. From these interviews it was learned that in most cases, where the cause of failure was not due to illness or something similar, the most frequent cause was inability to understand the significance of chemical formulas and equations and the quantitative deductions to be drawn from them. The Training Test consists of:

PART 1. A series of 45 questions on insight into the basic facts and theories of chemistry.

PART 2. A series of 45 questions involving valence, formulas and equation writing.

PART 3. A series of 50 questions involving general chemical knowledge of materials and phenomena of daily life, manufacturing processes and general chemical information.

PART 4. A series of 12 problems dealing with chemical and physical arithmetic.

Data and Conclusions Obtained from These Tests

It should be pointed out here that these examinations have for their aim much more than the prediction of scholastic success, and that their usefulness must be estimated according to broad pedagogical criteria. They are designed to "give aid in the setting up of educational conditions such that sound principles of student selection, class sectioning, motivation, and promotion may be more effectively applied to the securing of maximum effort and performance of each student."

TABLE I

CT-1 = Chemistry Training Examination
CA-1 = Chemistry Aptitude Examination

Name of college	Placement Examination	Number taking test	Correlation Scores vs. grades	Prob. error of "r"
Case School				
Appl. Science	CT-1	166	0.64	0.03
	CA-1	172	.57	.04
	CT-1 + CA-1	156	.66	.03
Univ. Hawaii	CT-1	79	.47	.06
	CA-1	29	.48	.10
Univ. Iowa	CT-1	82	.53	.05
	CA-1	150°	.42	.05
Univ. Saskatchewan	CT-1	19	.52	.11
	CA-1	19	.26	.14
	CT-1 + CA-1	19	.37	.13
Virginia Poly. Inst.	CT-1	281	.70	.02
	CA-1	278	.45	.03
	CT-1 + CA-1	100°	.73	.03

Average correlation Chemistry Training + Chemistry Aptitude = 0.59
Average correlation Chemistry Training = .57
Average correlation Chemistry Aptitude = .44
° Sample

Certain findings of a statistical nature which have bearing upon the capacity of the tests to do the things set up for them will be sketched at this point. They were obtained from the giving of the tests in their trial form to 918 students and 656 students, respectively, for Chemistry Aptitude and Chemistry Training. The first question which may be asked is, "Do the tests yield reliable (*i. e.*, stable) scores?" The coefficient of reliability of the Training test is 0.91, and the probable error of a single score, 1.7 score units. This indicates a high degree of consistency in the measure-

ment. A significant score difference would be 5 points and the obtained range from the highest to the lowest was 65. Thus it is clear that 2 or 3 groups can be organized into separate sections with very little overlapping in student abilities. Similarly, for Chemistry Aptitude the coefficient of reliability is 0.87; the probable error of a score 1.2; and the obtained range 45. Here also several sections may be organized with little overlapping in abilities.

A second question is, "How well did the tests predict success in chemistry as measured by semester grades?" This is shown in Table I. The values in Table I may be interpreted in various ways. It must be remembered that we are measuring but one group of factors which affect student success, and that variability in outside interests, in application, in health, in type of teaching, etc., are entirely neglected. Most of all there is the factor of unreliability of teachers' marks which are here used as the criteria of success. The high correlations reported indicate that the tests even in their first form are capable of predicting with reasonable accuracy.

At Virginia Polytechnic Institute it was found that every student who made a final semester grade of "A" scored above 66 in CT-1, while every student who failed to pass the semester's work scored less than 62. This is characteristic of all groups tested, even when the correlation is much lower. There is no difficulty in separating, during the first week in the fall, the group which will do very good work from the group which will do very poor work. Fortunately it is just this discrimination which is important for pedagogical purposes. But it has always been difficult to predict the performance of the middle group. Some colleges, for example, aim to give the grade of C to about 50% of the students. Now we have shown that the discrimination of the placement examinations is such that it will, at the beginning of the semester, break this large C-group into a number of groups really different in ability. When these existing differences are not maintained in the sense that they do not finally appear as grade-differences in semester performance, high prediction is not to be expected. This, of course, is not in itself an argument against the letter grading system. The degree to which we hope students will run true to their aptitude and training as measured at the beginning of their collegiate career depends upon our philosophy of education. A perfected placement examination should simply embody in a single brief unit all that we can learn about the student's probable fitness for the work in chemistry which is independent of the more general, but sometimes more potent influences of character traits and environmental conditions. The predictive power obtained thus far is greater than that of the general intelligence examination, or of the high-school record of the student; and it is probable that the revisions of the tests now available will enable higher correlations.

Value and Uses of These Tests

In the interest of giving a true statement of the origin and setting of this paper, it should be here interjected that these two tests are but a part of a more extensive program built around the placement examination idea. Under the general direction of Dean C. E. Seashore and Prof. G. M. Ruch, Mr. G. D. Stoddard in collaboration with members of the various departments of this University among whom the other author of this paper is one, has composed similar placement examinations for English, French, Spanish, mathematics, and physics as well as chemistry. A general exposition of the placement examination idea may be found in *School and Society*, November 8, 1924.[2]

We believe the chief value of examinations of this sort arises from the fact that at the very beginning of the year sectioning of quiz and laboratory classes on the basis of individual ability is possible. Where sectioning is done alphabetically, or on any other basis than ability to do the work, the retarding influence of a few slow students in a section where the majority are more able, or the discouraging influence of a few "very bright" students in a section of slower ones is well known. From experience we know the task of teaching is much aided by grouping students in sections of like learning capacity. In the first semester sectioning may be done according to the placement examination scores and in the second semester according to final grades made in the first semester. In departments where there is no necessity for stock-room bookkeeping and laboratory organization, students may be shifted from lower to higher sections or the reverse according to work done during the semester. Of course there are always the irregular and borderland cases, which merit individual judgment and adjustment. There is the more mature student who has been out of school for a number of years, who often gets in a section lower than his intrinsic merit warrants and there is the able student who will not work. These cases merit and, so far as possible, receive individual adjustment. We believe the number of cases of individual injustice arising from this source, is less when sectioning is done by this system than is done by any other available system with which we are familiar. The injustices arising from a few cases of this sort are apt to obscure the benefit accruing to the majority when the whole group is considered statistically.

A second and very real use of the training examination for teachers in institutions admitting students on the certificate plan is in connection with the very old and very much discussed question of "What shall we do with students who have had a year of high-school chemistry?" In the past many teachers of college chemistry have scorned all instruction in high-school chemistry, regarding it as utterly worthless, and giving students who have such a course identically or substantially the same instruction as they gave

[2] C. E. Seashore, "College Placement Examinations," *Sch. and Soc.*, **20**, 1–10 (1924).

students who never had any instruction in chemistry. We believe that in doing this college instructors have been "crying down their own wares" and discrediting their own subject. The effect of this practice is reflected in many states in the small and decreasing numbers of high schools offering courses in chemistry. Administrative officers in these states say, "If the subject has no value, why give it?" and act accordingly. Interesting statistics on this point are given in "The Junior College" by Koos. From our own experience we believe the following quasi-mathematical statement is a true statement of the quality of high-school instruction in chemistry.

$$\overset{\infty}{0}\left[(\text{High-School Chemistry}) > = < (\text{Freshman College Chemistry})\right]$$

Which in words is intended to read, high-school chemistry is better than, equal to, or worse than freshman college chemistry, between the limits of zero and infinity. As one approaches the limits this may be a bit exaggerated. Probably most college teachers will admit that some students from some high schools do know enough chemistry when they enter college to warrant trying to use this previous knowledge as a starting point for further instruction. But they are apt to add further that they have tried such a project and found such wide variations in the extent and quality of such training as to make impossible the offering of any coherent body of subject matter.

During the past five years, we have at the beginning of each year or soon thereafter given some sort of examination to all our freshmen who have had high-school chemistry. From the results of these examinations we have eliminated from the group from a fourth to a third of the poorer students. The ones eliminated take the regular first semester course for those who have never had chemistry. To the ones remaining we give during the first semester, the work regularly given in the second semester to students taking a first course in chemistry. In the second semester students who have had high-school chemistry and passed their work up to this point take quantitative analysis, thus making the year of high-school chemistry of students who can qualify equivalent to one semester of college chemistry. The success of this plan is conditioned by the accuracy with which we can sort students at the beginning of the year. Last fall we used the Iowa Training Examination (CT-1) as a basis for this sorting. The results were the most satisfactory of any we have thus far obtained. In mentioning this example of our own way of doing, we do so, not with the purpose of holding it up as a model or ideal scheme but only as a suggestion of what may be done. The essential point is that tests of the sort here discussed point to the possibility of both qualitatively and quantitatively evaluating training in high-school chemistry at the very beginning of the college year, in order that previous training, if of a quality to warrant, may at once be used as a starting point for more advanced instruction, thus eliminating

much needless repetition. The content of this advanced instruction may be varied to suit local conditions. A by-product which puts a premium on thorough high-school instruction is the stimulating of better teaching in high schools. Once the word gets around that an impersonal and objective evaluation is being put on high-school chemistry training, teachers and superintendents are anxious to know how their work ranks with that of other schools. Meritorious training is thus recognized and shoddy teaching brought to the light of day.

Other values that may receive briefer mention are: by giving placement examinations year after year the general quality of the student body of one year may be compared at the very beginning of the year with that of other years and the general trend become known. With more extended use it will be learned what things included in the placement examination have predictive value and what things have none. By knowing these we may learn that success in studying chemistry and other courses is only in part intellectual and that other qualities are equal or greater determinants. If these were accurately known and measured, educational administration could be more efficient and less wasteful than at present. The individual in choosing an educational program and a vocation for life would be vastly helped. But that is the end of the road. We are now only at the beginning and a long way intervenes.

Farmers Oppose Tuberculin Test. Cows as well as monkeys are doing their share in bringing science into the courtroom. The forcible ejection of Dr. Clark H. Hays, chief of the state bureau of animal industry, from the farm of John Burke of Elkhorn, Nebraska, on June 30, has resulted in contributions from farmers all over the state toward a fund to test their rights under the Nebraska law for the eradication of tuberculosis in livestock. Burke, according to Dr. Hays, refused to allow his stock to be subjected to the tuberculosis test in accordance with state law.

This test consists of injecting an extract of dead tubercle bacilli under the skin of the cow. Fever, swelling and inflammation at the point of injection constitute a positive test. Cattle with a positive test are condemned and killed.

The slaughter of thousands of cattle each year under the Nebraska law and similar laws in other states seems to be the basis of the farmers' rebellion. Their complaints that many of the cows which are slaughtered following a positive reaction to the test are found to be without traces of tuberculosis are in line with a series of investigations by Prof. E. G. Hastings and Dr. B. A. Beach, professors of bacteriology and veterinary science at the University of Wisconsin. They reported to the Society of American Bacteriologists at their December, 1924, meeting that in twenty Wisconsin counties in three years, 387,180 cattle were tested, and 5888 of these gave a positive reaction. Yet, on post mortem examination no evidence of tuberculosis could be found in 1279 of the positive cases. In some of these latter they found a germ very similar to the one which causes tuberculosis, except that it was apparently harmless. Prof. Hastings and Dr. Beach believe that this germ causes cattle to react positively and is the reason for many of them being needlessly slaughtered.—*Science Service.*

Chemical Digest

ABSTRACTS

The Place of Science in the Secondary School. G. W. HUNTER. *Sch. Rev.*, **33,** 370–81, 453–66 (1925).—The data consists of replies from 276 schools in 33 states in 1909 compared and contrasted with similar data in 1923 from many of the same schools and others to the number of 368. "The last decade has witnessed a new growth and a new spirit in secondary-school science." There has been a gradual but healthy increase in the total number of science courses given. The amount of time allotted to science courses during the year has also increased. Seven periods per week for physics and chemistry is the general rule. In botany and zoölogy the cases of five periods per week are nearly equal to the seven period plan. In other sciences the five period plan exceeds the seven. The position of physics and chemistry is divided between the third and fourth years. The swing toward physics in the third year of the high school and chemistry in the fourth is more marked in the Middle and New England States, while the tendency to place chemistry in the third year and physics in the fourth year is seen in the North Central Rocky Mountain and Pacific States. The increase in the number of chemistry courses is much greater than in those in physics. The writer finds general science well established in the first year, biological science in the second, with physics and chemistry in the third and fourth. A very decided trend toward the affairs of life and human events is noted in the teaching of biology, the same trend may be found in the other subjects, which may be interpreted as: "Modern science is really teaching how to live." H. R. SMITH

A Standard Liberal Arts College. GUY E. SNAVELY. *Sch. and Soc.*, **21,** 701–4 (1925).—Such a college would have about 600 students and 40 instructors. In the English department there would be 3 professors and 3 instructors of lower grade; in biology 2 professors and 1.5 lower; chemistry 2 professors and 1 lower; physics 1 professor and 1.5 lower. Average salary of professors $3400, asst. professor and instructors $2000. These salaries would have to be somewhat higher in northern colleges. Full professors and heads of departments should have Ph.D. or its equivalent. The training of all instructors is important but personality is much more so. The members of the college faculty also have an obligation of service to the community in which they live. SY.

College Qualifying Examinations. G. M. RUCH. *Sch. and Soc.*, **21,** 583–6 (1925).—Individual differences in mental and educational abilities make it desirable to properly place students at beginning of course. College qualifying examinations will help to individualize education. They will determine: (1) general mental ability; (2) previous academic training; (3) volitional, emotional and personality factors; (4) records of social, economic and general home conditions. Examinations in use at Stanford and Iowa. Results regarded highly significant especially by personnel officers. SY.

Educational Value of Nature Study. C. F. CURTIS RILEY. *Sch. and Soc.*, **21,** 573–83 (1925).—Nature study should include simple observations and demonstrations in chemistry, physics and physiology; inquiries about minerals, rocks, soil, water, fire, gas and smoke. The child wonders about objects and phenomena of nature. He feels he must know what these things are. Nature study develops imagination. If a child is to reach maturity with a proper insight into physical laws, forces, and products he must begin early to train both eye and understanding. SY.

Chemical Quackery. HARVEY A. NEVILLE. *Ill. Alumni News*, **3,** 214–5 (1925).—Advertising has betrayed science by taking advantage of an uninformed and credulous public. The faker, whether from the back end of his medicine-wagon or the back pages of the newspapers, will speak the jargon of science, dragging in vitamins, hormones, radio-activity and "tireless research." New cosmetics are spoken of as "achievements of engineering chemistry." The large number of fatalities resulting from carbon monoxide prepared the public mind for a spray to be used on the interior walls of garages for the purpose of absorbing this poisonous gas. Numerous instances of this type with emphasis on "health foods" and "beauty aids" are cited in this readable article.

The patent law and the pure food law are discussed in relation to a few of the "quack" productions. The author concludes that it is the duty of all those interested in the welfare of science to combat this exploitation of the public. R. M. P.

Inorganic Crystals. W. L. BRAGG. *J. Frank. Inst.*, **199**, 761–72 (1925).—Many inorganic salts have been found to have extremely simple structure as revealed by X-ray analysis, revealing no trace of evidence of association of atoms into definite molecules. Support is lent to the view of J. J. Thomson, Stark, Kossel, Lewis and Langmuir that the forces which bind the inorganic crystals together are electrical attractions between oppositely charged ions. The sodium chloride crystal here is cited; but with other types of crystals there is evidence of grouping of atoms into molecules. With organic crystals for instance, there appears to be linking by bonds with a definite spatial distribution over the surface of each atom, intimately related to its chemical valency. In inorganic salts geometry seems to determine the form, certain simple schemes of marshalling the ions being common to a large number of salts. There opens up a possibility of calculating the physical properties of crystals in terms of simpler atomic constants, as heats of formation, elasticities, natural free periods, specific heats and equilibrium configurations of inorganic salts. Several instances of connection between properties and structure of inorganic salts are described. Two alternative methods of packing of atoms in crystals are considered. Sodium chloride in cubical form illustrates the cubical, and calcium carbonate as calcite and aragonite illustrates the alternative methods of packing, the rock-salt-like method with compression along the trigonal axis, and the hexagonal method. The X-ray reveals the internal structure of calcite and aragonite to differ in such a way as to account for the greater density of the latter. The "pseudo-hexagonal" shapes of the orthorhombic aragonite crystals are accounted for as well as the ease of twin formation. The strong double refraction of both calcite and aragonite crystals is accounted for. "The birefringence of calcite and aragonite is explained quantitatively to a high degree of accuracy by the relative position of the oxygen atoms in the CO_3 group." Crystal structure will only receive a satisfactory explanation when we have full knowledge of the structure of the atom. A fascinating field of research is opened up in inorganic crystals. J. HOWARD GRAHAM

The Tenth Revision of the United States Pharmacopoeia. J. M. WHELPLEY. *J. Am. Pharm. Assoc.*, **14**, 467 (1925).—The Board of Trustees of the United States Pharmacopoeia Convention has selected January 1st, 1926 as the date upon which the new Pharmacopoeia becomes official. This book will probably be available for sale in the Autumn, so that those who are interested in the teaching of pharmacy and pharmaceutical chemistry will be able to provide quantities of this official standard for their classes. The pharmacists and chemists in this community may take pride in the fact that the centennial pharmacopoeia of the United States is the peer of any similar publication in the world. J. C. KRANTZ, JR.

The Three-Year Course. ZADA M. COOPER. *J. Am. Pharm. Assoc.*, **14**, 542 (1925).—The writer reviews very carefully the proposals for the three-year course in pharmacy and speculates on the influence this will have upon the future student body. Prof. Cooper believes that the advanced course will have a tendency to increase the calibre of the students matriculating in pharmacy and will in no way bring about a shortage of pharmacists in this country. J. C. KRANTZ, JR.

The Electrolytic Refining of Aluminum. F. C. FRARY. *Chem. & Met. Eng.*, **32**, 485–6 (1925); *Trans. Am. Electrochem. Soc.*, **47**, preprint (1925); *C. A.* **19**, 1665 (1925).—Aluminum is electrolytically refined from a bath of molten salts consisting of fused cryolite, aluminum fluoride and barium fluoride. The anode, a copper-aluminum alloy, rests on the bottom of the cell. The bath of fused salts forms a second layer above the anode and the cathode of molten aluminum floats on top of this. A diagram of the cell (Hoopes) is given together with working temperature, voltage and current required. A purity of 99.8–99.9% is obtained. Aluminum of this purity has properties which are quite different from those of ordinary aluminum. K. S. T.

The Coking and Swelling Constituents of Coal. FRANZ FISCHER. *Ind. & Eng. Chem.*, **17**, 707–10 (1925).—F. working with coals of various geological ages was able to extract by the aid of benzene at 285° the substances which are responsible for the coking and swelling of coals. This temperature was below the decomposition point of any of the coals. The benzene extract was separated into an oily petroleum-ether-soluble bitumen and an insoluble chocolate brown powder. The quantity of the oily bitumen increased with the geological age of the coal while the quantity of the solid bitumen decreased. The oily bitumen is shown to be the cause of coking while the solid bitumen causes swelling. The temperatures at which the solid bitumens decompose rise with the geological age. The swelling of the coal seems to be due to the decomposi-

tion of the solid bitumen at a temperature corresponding to the plastic state of the coal. This knowledge should permit the proper mixing of coking and non-coking coals necessary to produce good coke. Tables and photographs are included. K. S. T.

Simple Methods for Removing Frozen-In Glass Stopcocks and Stoppers. E. G. R. ARDAGH. *Can. Chem. and Met.*, **9**, 137 (1925).—To remove a stopper broken off flush with the neck proceed as follows: select an old stopper with a flat lower end about the same size as the exposed end of the stump to be extracted. Warm with a bunsen flame the exposed end of the stump and the lower end of the selected stopper and apply sealing wax to the two warm surfaces. Force the two surfaces into contact by pressure, at the same time using a twisting to-and-fro motion. When cool hold the bottle in a horizontal position and rotate the neck slowly over a small flame until the glass is warm but not too hot to hold in the hand. Place the bottle upright on the table, encircle the neck with the fingers of the left hand, press firmly with the thumb against the top of the stopper with a lifting sort of push, and with the square wooden handle of a spatula held by the blade, tap the opposite side of the top at about 45° to the horizontal.

For removing stoppers from a bottle containing alkali, draw over the neck a piece of rubber tubing. Pour into this some dilute HCl, evacuate, and then allow atmospheric pressure to force the acid between the ground glass surfaces. It may be necessary to repeat this several times. This method can also be used for removing stopcocks from burettes. E. G. V.

Synthetic versus By-Product Ammonia in Europe. C. H. S. TUPHOLME. *Can. Chem. and Met.*, **9**, 131–3 (1925).—A review and comparison of various methods of fixing nitrogen with a discussion of costs and future outlook. Though it is some ten years since the birth of synthetic ammonia, it is only within the last two years that reliable information with regard to the process has become available in the form of war-time investigations in America, France and Britain and reports of investigations in the occupied areas of Germany.

The world's demand for fixed nitrogen is increasing at a rate in excess of the supply, and the limit of production from sources depending upon coal distillation has been nearly reached. By-product ammonia now represents 27% of the world's supply of fixed nitrogen.

At present there is no serious competition between synthetic and by-product ammonia, but as soon as a favorable economic return can be demonstrated for synthetic ammonia, such plants will increase in number, supply will overtake the demand, and the price of by-product ammonium sulfate will be reduced. But it is doubtful if the competition between synthetic and by-product interests will be as keen as that between the Chilean producers and the combined synthetic and by-product interests.

European chemists believe that synthetic ammonia can be obtained at such a figure that ammonium sulfate will not cost more to manufacture than $30 to $40 per ton. Both the electric arc and cyanamide processes are more expensive than the Haber or Claude methods, and it is the development of the latter two that promises a lower price. Claude claims for his process a higher space-time-yield and lower installation costs than the Haber, though it is curious that, if these claims are justified, the French government has contracted for the erection of a Haber plant.

The four chief points uppermost in the minds of Europe's agricultural and industrial chemists as far as nitrogen is concerned are: (1) The value of fixed nitrogen as a fertilizer; (2) The cost of producing synthetic ammonia; (3) The available methods for increasing the yield of ammonia in by-product practice, not only by improvements to plants, but by the release of a greater amount of coal nitrogen without interfering with the essentials of distillation; (4) Dispensing with the use of the heavy item of cost, *viz.*, sulfuric acid, substituting fertilizers in which the ammonia is fixed by CO_2 etc. E. G. V.

Bacteriological Chemistry and Industry. A. E. MACRAE. *Can. Chem. and Met.*, **9**, 144 (1925).—Sketch of an address given by Dr. G. B. Reed at a meeting of the Ottawa Section, Society of Chemical Industry. The speaker discussed the relation of bacteria to chemical transformations in nature and in industries, and stressed the fact that these transformations result from the catalytic action of enzymes produced by the bacteria.

Living organisms differ from one another as a result of chemical differentiation of many constituents of protoplasm, and the building of these characteristic substances is largely the result of the specific action of the cellular enzymes.

In the fermentation industry a species of yeast is selected which produces a very active zymase and relatively inactive enzymes for other constituents of the fruit, and as a result a maximum of alcohol and a minimum of other substances are formed. In the dairy industry a species of coccus is selected which, growing in milk, produces an

enzyme which rapidly changes lactose to lactic acid and at the same time has very little action on other milk constituents. E. G. V.

Stop-Cock Lubrication and an Improved Lubricant. E. G. R. ARDAGH AND A. L. DAVIDSON. *Can. Chem. and Met.*, **9**, 137 (1925).—As a result of experimental work on Travers formula and other similar preparations the following combination, which fulfils the requirements of an ideal lubricant, was found: pale crepe rubber 7.5%; vaseline 77.5%; white paraffin wax (m. p. 128–130°F.) 15%.

The vaseline and paraffin are melted together in a beaker suspended in an oil bath. The rubber is cut into fine shreds and added in small portions, the mixture being kept in motion by a motor-driven stirrer. The temperature should be maintained at 130°C. for six hours. The mixture is solidified by pouring it while still just fluid in a thin stream on a cold aluminum plate. It is then transferred to a small screw-top salve pot for distribution. E. G. V.

The Man Who Soothed the Brow of Agony. *Gen. Sci. Quart.*, **9**, 188–99 (1925).—Two addresses, one by Francis M. Rackemann and the other by Frank P. Barnard in honor of William T. G. Morton, the eminent American doctor who in 1846 demonstrated the practicability of ether as an anaesthetic. H. G. TANNER

I Am a Chemist. BERTON BELLIS. *Gen. Sci. Quart.*, **9**, 89–90 (1925).—A unique presentation of the benefactions of chemistry. H. G. TANNER

The Graduate Schools of America. R. M. HUGHES. *Bull. Miami Univ.*, **1925.**—This is a study carried out by questionnaire and in collaboration with twenty members of the faculty of the Miami University. A list of 36 colleges and universities was sent to forty men teaching in each major subject. Returns were received from about half those addressed. For chemistry, forty-one men sent in ratings which placed the principal graduate institutions for chemistry in this order: Harvard, California State, Massachusetts Institute of Technology, Yale, Chicago, California Institute of Technology, Cornell, Illinois, Johns Hopkins, Columbia, Michigan, Wisconsin, Toronto, Stanford, Pennsylvania, Minnesota, Ohio State, Cincinnati, etc. Departments included in the study are: Astronomy, Botany, Chemistry, Classics, Economics, Education, English, French, Geography, Geology, German, Government, Political Science, History, Mathematics, Philosophy, Physics, Psychology, Sociology, Spanish and Zoölogy. In the report it is suggested that the smaller colleges look to graduate colleges for their teachers and actually employ a majority of the men and women trained in the graduate colleges. B. CLIFFORD HENDRICKS

The Chemical Warfare Service and Pacifism. W. A. NOYES. *Chem. Bull.*, **12**, 134 (1925).—We must not delude ourselves with the idea that we are promoting peace, however just our reasons for supporting Chemical Warfare Service. The Great War showed the fallacy of such a doctrine.

Recent incidents seem to indicate that nations still think they can serve their own interests better by the use of force than by submitting to some international tribunal and agreeing to combine against any nation that will not do this. In spite of this attitude, the machinery for judicial settlements is slowly gaining strength and is sure to win universal support as the peoples of the nations come to understand it.

If nations would only spend as much as one per cent of the money they use for increased armaments upon measures for promoting better understanding between nations and for instructing them in methods by which peace may be assured, armaments would become less and less important.

Duels are no longer countenanced in civilized countries as a means of settling personal disputes. Wars, which are international duels, are logically less defensible and will quite as surely disappear. We should seize every opportunity to hasten their end. B. CLIFFORD HENDRICKS

The Rhodes Scholar's Ideal Professor. WENDELL S. BROOKS. *Bull. Am. Assoc. of Univ. Prof.*, **11**, 281–82 (1925).—"The best college teacher I ever had expected more initiative and allowed more independence to students" according to the majority of Rhodes scholars questioned. Those qualities next in order of appreciation by this group were, "he was more careful in organizing his subject than other teachers" and "appreciated better the difficulties of students." The fourth characteristic in their judgment was, "There was more of an inspiration for clean, honest living in his teaching." Another attribute of this best teacher was, "His courses required more work than the average college course." This last expression will encourage teachers who are trying the plan of sectioning upon a basis of ability to expect more and better work from the brightest groups.

The Rhodes scholars who contributed to the study had studied at 23 colleges and universities of church or private origin and at 14 state universities. Twenty-two per

cent of them had been entirely self-supporting and 52 per cent had earned part of their college expenses. B. CLIFFORD HENDRICKS

An Outline of Obesity. HARVEY A. NEVILLE. *Ill. Alumni News*, **3**, 285 (1925).—In this popular-scientific article the author gives the truth in regard to a number of drugs and materials advertised for reducing weight. Some contain poisons and practically all are frauds. R. M. P.

How Can We Humanize High-School Chemistry? ALBAN FIEDLER. *Trans. Ill. State Acad. Sci.*, **17**, 417–20 (1925).—The paper summarizes a few devices which have been used successfully to teach principles and facts with reference to their application. R. M. P.

The Inter-Relation of the Sciences. PAUL L. SALZBERG. *Trans. Ill. State Acad. Sci.*, **17**, 157–62 (1925).—The author shows that if the inter-relation of the sciences is put to practical use as is being done in the border-land sciences, it will lead to a greater exhaustiveness and accuracy in scientific research. R. M. P.

Making Science Teaching More Effective in Relation to Life. H. A. HOLLISTER. *Trans. Ill. State Acad. Sci.*, **17**, 421–5 (1925).—The chief life contacts of science may be classed under health, morals, and industry.

The problem of health underlies the whole problem of human existence. The most fundamental call which human life makes on science is the instilling into the minds of youth of a sense of the value of life, the means of preserving it and projecting it on to coming generations with increased virility.

We need more teachers of science who make science a living thing that vibrates throughout all that is important and vital in our social and civic life. R. M. P.

The Public School Teacher as a Research Worker. B. R. BUCKINGHAM. *J. Educ. Res.*, **11**, 235–43 (1925).—The author makes two points: (1) the educational world needs the teacher as a research worker; (2) the teacher and the teacher's calling will be benefitted by research work.

A great deal of experimentation on learning questions is educationally ineffective because it is conducted under artificial conditions and restrictions. Suggestions are given for research which may be done more effectively where there are substituted, "the teacher for the psychologist, the school-room for the laboratory, and the class of pupils for the half-dozen learners."

The teacher as an experimenter has greater opportunities in the follow-up of findings than has the psychologist. A problem pursued by a psychologist is relatively theoretical and remote, whereas the same problem may be pursued by the teacher in its practical and immediate bearing.

The reaction of research upon the teacher will make him an expert teacher and will make his calling more attractive. He has the most interesting of all possible material to study, namely, human beings. The fresh point of view which research always engenders should not be denied to the teacher. R. M. P.

Chemistry of Sewage Treatment. A. M. BUSWELL. *Trans. Ill. State Acad. Sci.*, **17**, 147–56 (1925).—In the manufacture of relatively pure water from the combined water-carried wastes of a modern city, attention is called, first, to the raw material and the final product which must be produced; second, to typical factory layouts; and third, to some of the chemical reactions which take place.

The amount of sewage in American cities ranges from 75 to 100 gallons per capita per day. The amount of organic matter per gallon of sewage is comparatively small, and yet exceedingly objectionable.

Specific examples are described of typical Imhoff tank and sprinkling filter installations. This process affects the digestion, liquefaction, and oxidation of organic matter, the end products being $(NH_4)_2CO_3$, NH_4NO_3, and a black sludge.

The activated sludge process substitutes an aeration tank and a settling tank for the Imhoff tanks and filters. The activated sludge has practically the same chemical composition as microbial protein and is valuable as a fertilizer.

Dunbar's theory that the clarification and nitrification in the activated sludge tank is brought about by biological catalysts is supported in the microscopic examination of the sludge. This shows it composed entirely of communities of organisms made up of bacteria, yeasts, molds, and protozoa.

The chemical changes are much the same as those taking place in soils and fertilizers. When bacterial enzymes attack the organic matter progressive hydrolysis takes place with the formation of ammonia. If aerobic conditions prevail the nitrifying organisms oxidize nitrogen to nitrites and nitrates.

The reversal of these reactions has recently been demonstrated. Under anaerobic conditions nitrates are reduced and are then synthesized into protein of the microörgan-

isms. Likewise, free ammonia disappears, but protein is formed. Thus, in sewage treatment protein compounds may undergo hydrolysis, liquefaction and oxidation, or the reverse action may take place and protein be precipitated. R. M. P.

Recent Developments in Photo-Chemistry. W. ALBERT NOYES, JR. *Trans. Ill. State Acad. Sci.*, **17**, 136–40 (1925).—This is an interesting discussion of some of the principles of thermodynamics as applied to photochemical reactions by Einstein, Perrin, and others. The author believes that it is a fallacy to assume that one general theory will account for all reactions affected by radiation. A catalyst will not cause a reaction to take place unless the reaction has a tendency to take place without the catalyst. If a reaction leads to a decrease in free energy, a proper catalyst should increase the rate of reaction. If a reaction involves an increase in free energy the mere use of a catalyst will not cause the reaction to take place. In the case of photochemical reactions it seems that a similar distinction should be made. Arguments are given to show that only those reactions which involve a slight negative or a positive free energy change will follow a photochemical equivalence law. For the other reactions light seems to be capable of starting a chain process which continues until it comes to an accidental end. It is impossible to state at present the function of light in these reactions. The author concludes that the field of photochemistry is in a rather unsatisfactory state from a theoretical standpoint. R. M. P.

Overlapping in High School and College. LEONARD V. KOOS. *J. Educ. Res.*, **11**, 322–36 (1925).—A careful study of overlapping material in high-school and college chemistry. Twenty-six high schools and forty-one higher institutions are represented. The principal basis for comparing the content of high-school and college courses in chemistry is found in the textbooks and laboratory manuals, the use of which was reported by the heads of departments. Four figures are given which show graphically the comparison of the amount of space devoted by high-school and college texts to the various topics.

It is evident from this study that the college and high-school courses in chemistry resemble each other vastly more than they differ. If a student takes a course in general inorganic chemistry in college after having had the high-school course he is repeating almost all of it. R. M. P.

British Assoc. of Chemists—The Overcrowding of the Profession. H. T. F. R. *Chem. Age*, **12**, 609 (1925).—From figures collected by the Verein Deutscher Chemiker, it appears that the chemical profession has been greatly overcrowded since the war. This association advocates a reduction of one-third of the number of students trained. No figures appear to be available in England, but there is sufficient evidence to show that conditions in this country are very little better. Moreover the demand for chemists is smaller and it is not probable that the demand will increase.

In England the situation is aggravated by a condition which does not exist in Germany. In Germany entry into the profession is somewhat restricted but in England there is no control at all over the numbers who may compete in the market. This is the most serious aspect of the question and the possibility of regulating entry into the profession is suggested and the association appeals to all who contemplate the practice of chemistry as a career to consider well before they enter upon it. W. R. W.

Stainless Silver. (STAFF.) *Compr. Air Mag.*, **30**, 1280 (1925).—The fact that silver, which stains readily, has so long retained its status as a precious metal is remarkable. "The Engineer" tells about a new silver alloy which is practically stainless. It contains $92\frac{1}{2}$ per cent of silver—the other constituents not being revealed. So far, only about 600 ounces have been produced but manufacturers who have tried it report that it is easier to work than standard silver except during buffing and finishing. A test from Sheffield University showed that the new metal was hardly stained when exposed to corrosive gases and that the slight discoloration produced could be readily wiped off with a piece of dry leather. W. R. W.

Stop Coal Dust Explosions. J. B. ANDREWS. *Survey*, **54**, 744 (1925).—Many hundreds of lives are needlessly lost in coal dust explosions. Mine working produces a fine coal dust which settles and remains harmless until a shock of a local explosion throws it back into the air where it forms a highly explosive mixture. More than ten years ago government experts discovered that, by mixing the coal dust with a proper amount of rock dust, the resulting mixture is non-explosive. This can be done at a cost of ten cents per ton of coal mined. If legislatures and public officials could be made to function properly many lives would be saved. SY.

Is This a Cure for Tuberculosis? HAVEN EMERSON. *Survey*, **54**, 513–4 (1925).—"Sanocrysine" a complicated gold salt was prepared and clinical experiments made with it by Holger Moellgaard at the Serum Institute at Copenhagen. Ten healthy

calves were inoculated with fresh tubercle culture. Five were given sanocrysine, the other five got none. The latter all died, showing typical tuberculosis lesions. A few conservative and critical clinicians have tried it on human consumptives with gratifying results. It is certain that a new promising treatment for bacterial infections has been worked out on principles which appear sound theoretically and successful in practice. There is honest hope that blood poisoning, infectious heart disease and perhaps even pneumonia may be successfully attacked. Chemistry may establish itself as a great saviour of mankind. SY.

Instinct as a Guide to Food. B. HARROW AND C. FUNK. *Am. Mercury*, **5**, 489–94 (1925).—The word instinct is almost as vague as "chemical affinity." Authors adopted following definition for instinct: A propensity that urges an animal or human being without exercise of reason, to the performance of actions which are for the most part normal, useful or beneficial. Hunger is the sensation which first causes a desire for food. It is physiological. Appetite has important psychological elements. Instinct is the go-between bridging hunger and appetite. Professor Mendel's experiments with mice and rats showed that these animals selected foods which are as a rule advantageous for their nutrition. Primitive man probably used instinct as a guide in food selection. Professor Evvard of Iowa University showed that instinct of pigs is a safer guide in food selection than man-made standards. Until quite recently man lived on nature's produce and was healthy. During the last hundred years our foods have been changed greatly. They are preserved, purified, canned, processed, frozen, etc. Even our instinct has changed and is no longer a safe guide. Some psychologists say our instinct has become saturated with intelligence. Metchnikoff believed that our instinctive actions have become perverted largely by alcohol. Instinct won't tell us, food faddists mislead us, politicians and legislators are ignorant on the subject as a rule. Scientific experimentation must solve the problem. SY.

Art of the Perfumer. HENRY TETLOW. *Am. Mercury*, **5**, 57–8 (1925).—Originally good perfumes were mostly floral. The base was rose plus citrous elements such as geranium, bergamot and other florals. Perfumes today must be stronger, loaded with animal musks, civet, beaver musk and ambergris. Most so-called synthetic perfume materials are mixtures of natural primary materials. A few important ones are made from coal tar. There has been little progress in synthetics during the last twenty-five years. Perfume makers are slow to change formulas. They almost worship uniformity of product. All aromatic chemicals have one odor when raw, another when diluted, a third when mixed and a fourth when dried out. Perfume in the bottle never smells the same as on the handkerchief. SY.

Electric Production of Chlorine Gas. CARL W. ANDERSON. *Experimenter*, **4**, 611 (1925).—A solution of table salt is placed in an ordinary glass jar. Two metal plates, preferably copper, are immersed therein and when connected to some source of direct current at 12 volts or more, chlorine gas will be evolved. The gas may be collected in a glass which is filled with water, a piece of paper held over its mouth, and then inverted over the jar in which the salt solution is placed. The water dissolves much of the gas but the experiment is an interesting one. W. R. W.

U-tube Gas Generator. C. A. OLDROYD. *Experimenter*, **4**, 611 (1925).—A very simple gas generator for laboratory work, where only small quantities of gases are required, can be made from a glass U-tube. The tube should have a diameter of about one inch. The bottom of this is filled with pebbles. On one side the material from which the gas is to be generated is placed on top of the pebbles. The upper end of this arm of the tube is fitted with a stopper through which a small bent glass delivery tube passes. The other arm is left open and to generate the gas the tube is partly filled with dilute acid. Gas will be produced as long as the acid is in contact with the zinc (in the case of hydrogen). When the pinchcock over the supply tube is closed, the gas developed in the tube will force the acid back below the zinc and evolution of the gas will gradually come to a stop. The acid will rise in one arm but can never be forced out of the tube mouth, for as soon as the fluid has been forced beyond the lowest point of the tube, the gas will escape backwards in bubbles through the liquid in the bottom and other arm of the tube.

To filter the gas, a wad of cotton wool is placed below the stopper; any acid or other moisture in the gas will be absorbed by the wool, and the gas will be pure enough for ordinary experiments. W. R. W.

Vanadium—A Curiosity among Minerals. (STAFF). *Compr. Air Mag.*, **30**, 1252 (1925).—This silver-white metal derived its name from Vanadis, a Norse Goddess. It was discovered in 1801 by Del Rio, a mineralogist in Mexico, but it remained practically in oblivion for a century except in the form of museum specimens. In 1900

Professor Arnold at the University of Sheffield, Eng., conceived the idea that this metal might impart some beneficial properties to tool steel. At that time vanadium was considered a rare element and cost more than gold.

Two brothers by name of Flannery of Pittsburgh conceived the idea of obtaining financial aid from some business friends in order that the substance might be made commercially available to steelmakers. They located a rich deposit of vanadium sulfide in the Peruvian Andes at a point 16,000 feet above the sea. Without further details, vanadium is now an essential component in the composition of high speed tool steel. Vanadium imparts to steel the capacity to cut other metals at so high a speed that the tool actually becomes red hot and yet retains its cutting edge. W. R. W.

A Clearing House for High-School Information. (EDITORIAL.) *Educ. Rev.*, **70,** 44 (1925).—J. J. Tigert, U. S. Commissioner of Education, has organized in the National Bureau of Education at Washington a high-school service. It will be a repository of information made available through studies of high-school problems; it will furnish researchers with problems requiring solution; it will tabulate the results of the studies; it will distribute pamphlets. One set of agitators is protesting against large high schools while another claims that the large high school constitutes the only possible device by which the varied wants of young people can be fulfilled at a reasonable cost. Little high schools are paying as high as $1000 a year per pupil for educational costs as against a per capita cost of $194 in the larger schools. The cosmopolitan high school, insisted on by many Davenports and Thorndykes, has established itself. Variety of studies has gained added argument from psychologists reports on the variety of pupils' aptitudes. Rising costs have indicated barriers which must be removed. Mr. Tigert's idea to avoid waste effort and to pool experience and judgment will be a decided help. W. R. W.

A Study of the Achievement of High-School Students in Chemistry. JOHN W. RAUTH. *Catholic Educ. Rev.*, **23,** 289–92 (1925).—The author of this article bases his discussion on material from Powers in Teachers College Contributions to Education, No. **194** (1924), and Rauth-Foran in *The Catholic Educational Review*, **1924,** pp. 272–8, 546–50. He presents excellent lists of questions and reveals definite weaknesses in essential student products in the teaching of high-school chemistry by drawing illuminating conclusions from lists of answers to those questions. An enumeration of the weaknesses thus found are: knowledge of daily-contact things; the classification of common substances as elements, compounds and mechanical mixtures; knowledge of the trade names of important substances; the application of chemical principles to every day problems; greater weakness in knowing formulas for salts than for corresponding acids; failure to solve chemical problems does not follow a deficiency in writing formulas but a poor concept of the meaning of formulas and equations, lack of interest in problem work and poor knowledge of arithmetical proportion.

Finally the author comments pertinently on the following difficulties of high-school students: a need of more preliminary training in science; lack of interest in subject matter due to a violation of the principle of apperception in not linking chemistry up constantly to facts already familiar, in not getting acquainted with local industries, and in not pointing out the opportunities afforded by chemistry as a means to earning a living; and lastly the need of stressing laboratory work. LOUIS W. MATTERN

The Philosophical Basis of Biochemistry. JOSEPH NEEDHAM. *The Monist*, **35,** 27–48 (1925).—The unfortunate tendency of the scientific worker is to concentrate thought on details of technique and on "facts," leaving speculation to philosophy. The validity of the scientific method depends upon philosophical considerations. N. historically discusses neo-vitalism and mechanism. The former is thoroughly unsatisfactory and mechanism is only so when it attempts to extend its domain over consciousness. The aim of modern biochemistry is not to draw the line between living and non-living substance but between mind and body. The fundamental problem of the biochemist, the Nature of Life, is partly philosophical. T. G. T.

To Extract Bromine from the Ocean. (STAFF.) *Compr. Air Mag.*, **30,** 1292 (1925).—Since bromine does not occur uncombined in nature it requires chemical manipulation for its production. It has become more or less essential to modern chemical operations but the supply is not equal to the demand. To relieve the situation the American Chemical Society has chartered the steamer "Ethyl" for the purpose of extracting bromine from the water of the ocean. One pound of bromine is contained in about seven tons or 1700 gallons of sea water. With an unfailing supply of raw material to work on, the enterprise should find continuous employment. W. R. W.

Local Activities and Opportunities

Cornell University. During this past year Dr. E. M. Chamot has been the American Exchange Professor in France. He has delivered lectures before the Universities of Bordeaux, Toulouse, Montpellier, Marseilles, Grenoble, Nancy, Strasbourg, Lille, Rennes and Sorbonne, on the microscope and its uses.

Dr. L. M. Dennis and Dr. W. R. Orndorff have both been enjoying their sabbatical leaves from the university for the past term in Europe. Dr. Dennis has been traveling extensively in England and on the Continent where he has conferred with many of the foremost scientists, while Dr. Orndorff has been spending his vacation in Italy and Switzerland. They will return to Ithaca in September.

During the summer Dr. Yoshio Okayama, Professor of Electrochemistry at the Kyushu Imperial University at Fukuoka, has been at Cornell studying with Dr. Briggs. He intends to leave for Germany about the middle of August to continue his studies there.

Two recipients of the Commonwealth Fund Fellowships, Frederick M. Brewer, B.A., Oxford, and James Craik, Ph.D., St. Andrews, who are to come to Cornell to continue their study of chemistry, are expected to arrive at Ithaca in September. They will continue their study here during the academic years 1925–1927.

It is expected that Dr. Alexander Findlay will visit Cornell to deliver a lecture before the American Chemical Society on September 22nd, during his tour of the United States after the Los Angeles meeting.

Oberlin College. Dr. Harry N. Holmes of Oberlin College sails for Europe on September 2nd from Quebec. He expects to spend a month in Paris and then settle his family at Antibes on the Riviera for a few months using this place as a base for visits to the colloid chemists of France, Germany, Sweden and Holland. In the spring Dr. Holmes will spend a few months as a guest in Donnan's laboratory at the University of London. For six years Dr. Holmes has been Chairman of the National Research Council Committee on the Chemistry of Colloids.

Florida. The Department of Chemistry of the University of Florida announces the appropriation by the State Legislature of $220,000 for the erection of the first unit of a million dollar building for chemistry and pharmacy.

The following additions have been made to the chemistry staff: Harold G. Oddy, Ph.D., University of Toronto, Assistant Professor of Chemistry, and Burton Otte, B.S., curator for the department.

An anonymous gift of $1500 for research on Citrus Juice Preservation has recently come to the Department of Chemistry. The preservation of citrus fruit juices is a very attractive problem that is of considerable economic importance to the state of Florida. The Fellowship Committee has appointed Mr. M. B. Matlack as Citrus Fellow. Mr. Matlack is a graduate of the University of Florida and Georgetown University. He has had five years' experience in the citrus fruit industry. The research will be under the direction of Dr. Townes R. Leigh, Head of the Department of Chemistry.

Wisconsin. The National Academy of Sciences will hold its autumn meeting at the University of Wisconsin on November 9th, 10th and 11th. Prof. C. K. Leith of the university is chairman of the committee in charge of arrangements for the meeting.

Brooklyn Polytechnic Institute. Be-

ginning next September, the Brooklyn Polytechnic Institute will add graduate courses in chemistry and chemical engineering leading to the Master of Science degree. These courses are open for day or evening registration and are designed particularly for graduates of chemical courses who are engaged in technical work in Greater New York or vicinity, and who have felt the need of taking advanced courses.

The courses include: advanced physical chemistry; advanced organic analysis; drying, evaporation, and distillation; advanced general physics; modern physics; and thesis.—*Ind. Eng. Chem. News Ed.*

Minnesota. The total enrolment of the University Summer Session is about 3800. The lectures on Colloidal Chemistry given by Professor Herbert Freundlich are attracting much attention.

On Thursday, July 9th, Professor Freundlich addressed the weekly summer school convocation on the subject: "The Importance of Colloidal Chemistry."

A series of popular lectures on scientific subjects has been arranged for the benefit of summer session students. These are as follows:

1. July 3rd—"Chemistry in Everyday Life," by Assistant Professor R. E. Kirk of the Division of General Inorganic Chemistry.
2. July 9th—"The Life of a Bee," by Professor Francis Jager, Chief of the Division of Beekeeping.
3. "Chlorophyl and the World's Energy," by Associate Professor J. J. Willaman of the Division of Agricultural Biochemistry.
4. "Some Aspects of Biology," by Assistant Professor Minnich of the Division of Animal Biology.
5. "Earthquakes and Their Causes," by Professor Stauffer of the Department of Geology.
6. "Perfumes," by Professor G. B. Frankforter of the Division of Organic Chemistry.

Professor Paul H. M. P. Brinton, Chief of the Division of Analytical Chemistry, has returned to the university after a year's sabbatical leave, spent in study in Paris and London.

Recent promotions at the University of Minnesota include: Dr. Walter M. Lauer to Assistant Professor of Organic Chemistry, and Dr. Landon A. Sarver to Assistant Professor of Analytical Chemistry.

N. E. A. C. T. The following meetings of the N. E. A. C. T. are scheduled for the year 1925–26:

October 30—Portland, Me., joint meeting of the Northern Division with the Maine State Teachers Association.
November 14—Wheaton College, Norton, Mass. Annual Meeting.
December 5—Bridgeport High School, Bridgeport, Conn. Joint meeting of the Western Division with the Chemistry Teachers Club of New York and the New Haven-Bridgeport Section A. C. S.
February 13 (1926)—Everett High School, Everett, Mass.
March or April—Southern Division, meeting place undecided.
May 15—Springfield, Mass., Western Division.
November 13—Boston College, Boston, Mass.
December 4—Crosby High School, Waterbury, Conn.

Programs of the individual meetings will be published in a subsequent issue of the JOURNAL.

Leland Stanford University. Dr. Alexander Findlay, Professor of Chemistry in the University of Aberdeen, who has been lecturing at Leland Stanford, will spend some time in the East immediately following the Los Angeles meeting of the A. C. S. Until September 19th he will be in the vicinity of Chicago visiting universities and industries. On the 20th and 21st he is due at Rochester, 22nd at Ithaca, 23rd at Philadelphia, 24th at Pittsburgh, 25th, 26th, 27th at Washington, and the 28th at Baltimore.

Local A. C. S. sections are planning special meetings in his honor.

Recent Books

Introduction to Theoretical Physics, Vol. I. ARTHUR HAAS, University of Vienna. D. Van Nostrand Co., New York, 1925. xiv + 331 pp. 22.5 × 14 cm. $6.00.

This text should prove of inestimable value not only to those directly interested in physical science alone but also to all who are concerned in any of the related sciences that make use of physical principles. The theoretical physicist has hemmed himself and his work in with a wall of higher mathematics and "newer" physics that the student with the average training in mathematics and physics is unable to scale. Consequently many of the advances made in theoretical physics have not been available for the average student.

Professor Haas furnishes the means of access to the results of this field of research, hitherto closed to many who have hesitated to enter because of the fearful, awe-inspiring array of mathematical symbols and notation, or deterred sometimes by the labor-saving device, in the development of principles, of omitting steps essential to the reader for his full understanding. Beginning with the fundamental principles of "classical" physics the reader is led by easy, logical steps, by mathematical processes never beyond those of the elementary calculus, to an intelligent comprehension of the work that is being done in modern physics. The reader is enabled to bring his knowledge of physics up to date by the explanation of the methods of attack and the lines of reasoning used by the modern physicist.

The text is very readable, the representation remarkably lucid and interesting, all the possible difficulties having been removed by complete discussions and derivations, with no steps in the reasoning left out. A careful study of this book will furnish the average student with an intelligent survey of the field of modern theoretical physics, affording a means of grasping the fundamental concepts involved without the necessity of struggling through a jungle of details irrelevant to his purpose. For the student who desires a more thorough knowledge this text serves as an admirable introduction.

This first volume is divided into two parts, "Mechanics" and "Theory of the Electromagnetic Field and of Light." Under "Mechanics" by means of vector notation are discussed the general principles of mechanics and the motions of free material particles, rigid and deformable bodies. The theories of vector fields, of vibrations and waves, and of potential are dealt with at length.

In Part II are developed the inter-relationships of the fundamental principles of electrostatics, magnetism, and electrodynamics. Maxwell's theory of the electromagnetic field and the theory of light are treated fully. Of special interest are the sections devoted to electromagnetic mass, to the optical behavior of metals, and to the propagation of light in crystals.

In the appendix are found an index and a comprehensive summary by sections of the whole text.

C. G. EICHLIN

An Introduction to the Practice of Organic Chemistry in the Laboratory. HOMER ADKINS AND S. M. MCELVAIN, University of Wisconsin, McGraw-Hill Book Co., Inc., New York, First Edition, 1925. v + 288 pp. 14 × 20 cm. $2.25, postpaid.

The greater number of laboratory manuals in organic chemistry may be classed in two divisions: detailed directions for numerous preparations, or a *multitude* of qualitative tests based on characteristic reactions. The book under review appears to be a compromise between the two types.

The object of the book is "to help the student grasp the broader conception which a particular preparation illustrates, and at the same time to acquaint him with current practice in laboratory operations." The underlying principles are brought out by discussions of the mechanism and limits of the reactions used, and by questions which the student is called upon to answer in his report. The second object is accomplished by extended discussion of the laboratory technique involved in each procedure.

An unusual feature which is worthy of commendation is a chapter on the literature of organic chemistry, and one of the exercises is a "library problem." Since most institutions have not as yet introduced courses in chemical library work, this seems a very valuable addition to the visual course in organic chemistry.

The reviewer believes that this work will assist greatly in arousing interest in organic chemistry, since, with its clearly written explanations, and its demanding of the students a knowledge of the theory before beginning an experiment, it should entirely eliminate the empirical mixing of the "cook-book."

The book should enjoy a wide popularity, not only as a laboratory manual, but as a reference work for teachers using other texts.

JOHN H. GARDNER

Laboratory Studies in Chemistry. R. H. BRADBURY, South Philadelphia High School. D.

Appleton and Co., New York, 1923. xii + 198 pages. 12.9 × 18.8 cm. $1.00.

This neat little laboratory manual is written to accompany A FIRST BOOK IN CHEMISTRY by the same author. There are 92 experiments, 22 of which are indicated as of fundamental importance by asterisks in the Table of Contents. Students majoring in Domestic Science will find 11 experiments marked with a D. Freedom for choice by the teacher is allowed by numerous optional experiments.

A happy choice of types sets off the different parts of each experiment. Questions are in italics; each question forms a paragraph by itself; and the questions are usually grouped at the end of the experiment or subdivision thereof.

Most of the experiments are those usually found in laboratory manuals of elementary chemistry. There are 12 quantitative experiments and all but two of them are placed at the end of the book.

Directions are worded with an attempt to effect improved handling of apparatus. Fifty-seven line cuts illustrate the directions. The appendix contains 18 pages of helpful tables.

WILHELM SEGERBLOM

Intermediate Chemistry Companion. JAMES KENDALL, Columbia University. The Century Co., New York and London. 1925. 197 pp. 20.5 × 13.5 cm. $1.35.

This book practically parallels its predecessor by the same author, the College Chemistry Companion, written expressly as a supplement to the Kendall revision of Smith's College Chemistry, and is intended to supplement the corresponding Smith-Kendall Intermediate Chemistry. It is accordingly somewhat restricted in scope and treatment, but otherwise shows few changes of importance.

Many teachers complain that elementary textbooks of chemistry present the subject in a formal, not to say formidable, and academic manner. They contend that these texts follow a time-honored precedent and that they do not convey the spirit of present day science with its intense appeal to human interest. If the purpose of the text is to instruct the beginner, "Why," they ask, "should it not address him directly in a manner to excite his interest and stimulate his voluntary effort?" Others contend that it is not the proper function of a text to do this, but rather to present a clear systematic account of the science as it appears to the chemist, without any pedagogical pretense. If so, then some supplement to the text appears to be necessary; for the average student approaches his study of chemistry with a very meager appreciation of its nature and importance, and almost wholly lacking in knowledge of how to study any science.

Most of us will agree with the author of the present volume that "the average student 'taking' chemistry for the first time will not take it very far unless his regular lecture and laboratory periods are supplemented in several ways." Professor Kendall believes that this is best accomplished by a thorough training in chemical calculations. "Problem work," he says, "should be the most interesting branch of first year chemistry; it is only too often the most monotonous." "Only through continued practice in solving numerical exercises can a beginner appreciate fully the significance of the various topics discussed in his textbooks. A series of carefully selected problems will demonstrate to him as nothing else can, the concrete applications of abstract chemical theory to industry and to everyday life."

The value of such problem solving is often lost by the practice of referring the student to unrelated auxiliary books on chemical arithmetic, or by assigning a group of problems at the end of a chapter of the text. The virtue of the author's method lies in the fact that the problems are introduced at the time when needed to supplement the study of the text; for the chemistry follows the text systematically, chapter by chapter and experiment by experiment.

But the companion is by no means merely a problem book; it is a guide to the interpretation of text and laboratory work and it seeks to stimulate the interest and effort of the student by pointing out the "high spots" in each chapter, stressing the important ideas and correlating the minor facts. Graphic methods of representation are freely used and topics of special difficulty are selected for more detailed discussion and illustration. At times the language is delightfully informal and conveys the spirit of a sympathetic teacher, but unfortunately the author apparently momentarily forgets this style and lapses into the academic diction of the more formal text; for some of his explanations seem more difficult of comprehension than the corresponding statements of the text itself. But these are minor faults and do not obscure the great virtues of the author's presentation.

Especially praiseworthy is the Appendix on "Who's Who and What's What in Chemistry," containing a paragraph on "The Present Age is the Age of Chemistry," also paragraphs on "Nobel Prize-Winners in Chemistry"; "Nichols Medal Awards," "Perkin Medal Awards," and "The American Chemical Society," followed by a heart-to-heart farewell chat with the student and a bibliography of interesting articles for vocational guidance and supplementary reading.

Mechanically the book measures up to the standard of its publishers and is delightfully free from the common typographical errors so often found in poorly proofed first editions.

While intended expressly for the use of the student, instructors and laboratory assistants will find it interesting and helpful.

Teachers will naturally differ in their opinions as to the proper content of such a student's companion and the emphasis to be placed upon

different phases of the work, just as they differ concerning methods of instruction in the classroom; for the personality of the teacher is the important factor in both cases. The author is to be congratulated upon his recognition of the real need for such a book, and even more upon his courage and enterprise in attempting to meet this need. How well he has succeeded is indicated by the favorable reception already accorded his book. We may well leave the final appraisal to the many teachers who will gladly give the Intermediate Chemistry Companion a fair trial and to the students themselves who are the real judges of its chemical companionship. G. A. ABBOTT

A Pronouncing Chemical Formula Speller and Contest Guide. C. A. JACOBSON, West Virginia University. The Williams and Wilkins Co., Baltimore. xviii + 279 pp. 13.5 × 20.5 cm. $4.00.

The appearance of this book on the market is due to the success achieved by recent chemical spelling matches. It will be received with open arms by many teachers, partly because of the help it will give in such matches and partly because of the vast amount of data condensed in its pages.

Its scope is best expressed in the words of the second paragraph of the introduction:—"The present volume contains about 2850 names of inorganic chemical compounds together with their formulas and waters of hydration. It also contains more than 1000 names and formulas of the more common organic compounds, as well as in the neighborhood of 300 minerals. In addition to these three lists of compounds, the volume contains 1554 questions and answers covering the typical chemical reactions of all the accredited chemically active elements. The answers to these questions are expressed in the form of balanced equations."

The lists are very full. The presence of five Hafnium compounds shows they are up to date. The questions and answers covering typical chemical reactions are unusually full. Here, as in the lists, the rare metals are given much prominence. It is refreshing to see the name beryllium given preference over glucinum.

That great care has been taken to have the text accurate is shown by the fact that numerous authorities such as Prof. C. James and Prof. E. C. Franklin, have contributed from their respective fields and have read proof thereon.

The use of the prefix "thio" for "sulfo" shows an attempt to bring nomenclature in line with that used in the A. C. S. publications. The names in the lists are syllableized, accented, and marked with diacritical marks, for the last a helpful key to pronunciation being given. There is no hint as to why some names are printed in caps and some in small type. Two pages are devoted to describing the method of conducting spelling matches and using the speller.

It is unfortunate that in the formulas for hydrated salts the period is raised above the line, because in mathematics this means multiplication, and there is an attempt under way to have a series of signs and conventions that shall be consistent for all the scientific subjects commonly taught in the schools. If separate lines were used for the several salts, when salts with varying amounts of hydration are given, much might be gained in clearness so far as the student is concerned.

The reviewer has made no attempt to find mistakes in the names or formulas; his eye did not catch any as he glanced over the lists; any such mistakes, if present, will show themselves to those who use the lists. The statement that "Modern tendency warrants***the calling of the metal, represented by the symbol Al, aluminum instead of aluminium" seems rather strong in the light of divided usage and of the feeling many have that the names of the metals should, for consistency's sake, end in -ium so far as possible.

In spite of the fact that much effort was taken to attain consistency in nomenclature (see pages xiv and xv) one's confidence is shaken a little on seeing "University of West Virginia" on the jacket, "West Virginia University" on the title page and in several other places, and "West Virginia university" (with the first letter of "university" not capitalized) in another place. One must not look for too great freedom from little errors, however, in the first edition of a book of this sort. WILHELM SEGERBLOM

High School Chemistry. CHARLES E. DULL. Henry Holt & Company, New York (1925). xi + 577 pp. 18.5 × 12 cm. $1.80 postpaid.

The High School Chemistry, by Charles E. Dull, is an attractive and substantially bound volume, just published by Henry Holt & Company. The illustrations throughout the book are especially modern and commendable. It follows, in general, the order of the average high-school texts, which are the most popular and satisfactory, with some changes of arrangement and addition which are especially interesting. Some of these I heartily approve. Others I do not endorse without question.

All the organic chemistry (carbon and its oxides, treated in two chapters, following the order of the average text) is treated at the end of the book, so that it may be used, in the words of the author "for students who will not go to college, certain topics may be omitted to gain time for the study of the chapters on the compounds of carbon." In my opinion, the chapters on organic chemistry are as important to those who go to college as to those who do not, and are almost as important as any of the subjects treated in the high-school text. Many of the college texts do not emphasize organic chemistry, and some teachers omit it entirely, necessitating a special course, even for those who go to college. The great majority of college students taking

chemistry do not take this course, and therefore get little or no organic chemistry. In any course in high-school chemistry, the compounds of carbon are very important.

A great deal of the theory; *i. e.*, atomic theory, atomic and molecular weights, valence and equation writing has been grouped in a number of consecutive chapters. The arrangement is questionable. Will it not tend to give mental indigestion on theory? Is it not better that the theory be introduced where it explains facts arrived at by experiment as they are learned?

A very commendable feature, compared with other books, is that much less space has been given to the different metals. This is justified in the words of the author in "that the principles of metallurgy can be taught better by means of a few typical metals than by a great variety of them. Thus the reduction of iron ores with carbon is typical of the processes used in extracting the ore of copper, tin, and zinc. In like manner, the electrolysis of bauxite illustrates another important method of extracting metallic elements. The metallurgy of magnesium, calcium, sodium, and potassium is too similar to need much further detailed study."

Two interesting chapters on colloids and the chemistry of the War have been introduced which emphasize the modern aspects of the uses to which chemistry is being put.

A very great improvement has been made in teaching the pupil to write equations, especially those involving oxidation, in that difficult equations are worked out by the partial equation method.

A feature of great value is the summary at the end of each chapter, followed by a series of questions and problems, some of which are practical applications of the content of the chapter.

Dull's High School Chemistry, taken as a whole, has few objectionable, and many commendable features, and is one of the best modern textbooks published within the last several years. It will repay careful investigation by any chemistry teacher. SANFORD SWEET

TO BE REVIEWED LATER.

Qualitative Analysis—NOYES

Lecture and Laboratory Experience in Physical Chemistry—VAN KLOOSTER

Sulphuric Acid Concentrations—PARRISH AND SNELLING

College Chemistry—NEWELL

Modern Inorganic Chemistry—MELLOR

The Effects of Ions in Colloidal Systems—MICHAELIS

Physical Chemistry—PHILIP

Second Year College Chemistry—CHAPIN

Bacteriology—A Text Book on Fundamentals—THOMAS

Early Steps in Science—WEBB AND DIDCOCT

Fish-Poisoning Plants Now May Be Insecticides.—That the age-old custom of intoxicating or poisoning fish so that they may be easily caught, as practiced in Madagascar, India, Ceylon, the Ivory Coast, Central and South America, and other tropical parts of the world, may be the forerunner of a very beneficial discovery for the same peoples, is the prediction of Monsieur Auguste Chevallier, in presenting his recent findings on the subject to the Academy of Sciences in Paris.

For many centuries the natives of these lands have been in the habit of using certain plants for capturing fish. The method of using these narcotic growths to catch fish is by taking the leaves and bruising them in a mortar. Thus crushed, they are put in sacks, which are thrown in the ponds where fish are known to exist. Several natives go out and stir up the water around this "belt" of narcotic material, while the others chase the fish toward the poisoned area.

As the fish pass through the poisoned zone, they become intoxicated or are killed, and float to the surface, where it becomes only necessary to gather them in. So far as has been discovered, this poisoning does not make the fish harmful in any manner to the natives.

As these plants drop out of use one way, they seem to be turning toward another and even more beneficial service to mankind. A chemical called "tephrosine" has been isolated from the tephrose group of plants by M. Hanriot, a chemist. A small dose of this compound kills instantly the fish that come in contact with it. Lately three English investigators, Tattersfield, Ginningham, and Morris, have showed that this drug can also be used to kill harmful insects. And here the plants of this group, which are still under cultivation, may play an important part in the warfare of man against insects.—*Science Service.*

"A Few Moments with the Business Manager"

We believe the following letters will be of interest to our readers:

July 7, 1925

"I have been a subscriber to the Journal of Chemical Education since its second issue. At first I had a feeling that the Journal was a somewhat puny effort, but this feeling has been disappearing very rapidly indeed during the last few months. The last two issues have contained some of the most interesting chemical reading matter which I have seen in a long time. If the Journal keeps on at this rate, every chemist will have to become a subscriber. Needless to say, I am always glad to help along any movement such as this which improves and advances our profession."

(Signed) F. C. WHITMORE,
Head of Department of Chemistry,
Northwestern University

July 7, 1925

"I have noted with much interest the growth of the Journal of Chemical Education. It is a welcome Visitor to my study. If science is not 'prose' to our students it is because we are able to present it in brighter color and more attractive garb than pictured by the books. This is what the Mills College girl did with the elements in her 'bedtime story for wide awake children' in the June number of the Journal.

"I am convinced that much can be done to make the appeal of chemistry more attractive to students and the Journal can take its place in making it so."

(Signed) H. K. BENSON,
Head of Department of Chemistry,
University of Washington

July 3, 1925

"I have been much impressed with the splendid condition of the Journal of Chemical Education, and I am insisting that my students who expect to teach chemistry become subscribers. The Journal is handling the principles of chemical education in a most effectively balanced manner. There is a very stimulating variety of material, so that the interests of teachers of every type from those in simple laboratories in small high schools to those in the high positions in great institutions, are served."

(Signed) H. A. WEBB
Head of Department of Chemistry,
George Peabody College

"Our Shopping District"

Each month our readers have brought right to them, a "Shopping District" through which it would take hours to travel should we be obliged to walk through the maze of buildings and streets which are maintained by the various concerns.

The display windows of this "District" are the advertising pages in the front and back of the Journal. Here new ideas, apparatus, books, etc., are brought to our attention. By reading these pages we are kept abreast of the most recent developments in a variety of forms and thus we can intelligently inform our students and friends of whom the various materials may be purchased with the assurance that quality along with promptness and efficient service will be obtained. Further, such materials will be made by American concerns with which many of our boys and girls will ultimately become directly or indirectly connected.

Another point of interest about these show windows is that there is romance back of each display. Truth is always stranger than fiction. The development of a new dye, new spectroscope, new chemical, new textbook, new glassware, etc., has more real romance than is featured in the best fiction sellers of the day.

We can do more than look in the show windows. All these enterprising concerns will consider it a real opportunity as well as a pleasure to be asked to furnish information about their organizations, products, etc., which would be of importance to us as progressive teachers and intelligent laymen. We are proud of our "Shopping District" and we know our readers appreciate the progressiveness of the concerns whose foresight has led them to display their wares with us.

"WHEREVER POSSIBLE BUY OF OUR ADVERTISERS"